TITLE

HERBICIDAL PYRIMIDINES

FIELD OF THE INVENTION

This invention relates to certain pyrimidines, their *N*-oxides, agriculturally suitable salts and compositions, and methods of their use for controlling undesirable vegetation.

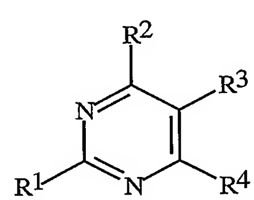
BACKGROUND OF THE INVENTION

The control of undesired vegetation is extremely important in achieving high crop efficiency. Achievement of selective control of the growth of weeds especially in such useful crops as rice, soybean, sugar beet, corn (maize), potato, wheat, barley, tomato and plantation crops, among others, is very desirable. Unchecked weed growth in such useful crops can cause significant reduction in productivity and thereby result in increased costs to the consumer. The control of undesired vegetation in noncrop areas is also important. Many products are commercially available for these purposes, but the need continues for new compounds which are more effective, less costly, less toxic, environmentally safer or have different modes of action.

World Patent Application Publication WO 92/05159-A discloses pyrimidines useful as plant protectants, especially fungicides. European Patent Application Publication EP-136976-A2 discloses pyrimidines as plant growth regulators. U.S. Patent 5,324,710 discloses sulfonated heterocyclic carboxamide derivatives of pyrimidines as herbicides and growth regulators.

SUMMARY OF THE INVENTION

This invention is directed to a compound of Formula **I** including all geometric and stereoisomers, *N*-oxides or agriculturally suitable salts thereof, agricultural compositions containing them and their use as herbicides:



I

wherein

R^1 is cyclopropyl optionally substituted with 1–5 R^5, isopropyl optionally substituted with 1–5 R^6, or phenyl optionally substituted with 1–3 R^7;

R^2 is $((O)_jC(R^{15})(R^{16}))_kR$;

R is CO_2H or a herbicidally effective derivative of CO_2H;

R^3 is halogen, cyano, nitro, OR^{20}, SR^{21} or $N(R^{22})R^{23}$;

R^4 is -N(R^{24})R^{25} or -NO_2;

each R^5 and R^6 is independently halogen, C_1–C_6 alkyl, C_1–C_6 haloalkyl, C_2–C_6 alkenyl, C_2–C_6 haloalkenyl, C_1–C_3 alkoxy, C_1–C_2 haloalkoxy, C_1–C_3 alkylthio or C_1–C_2 haloalkylthio;

each R^7 is independently halogen, cyano, nitro, C_1–C_4 alkyl, C_1–C_4 haloalkyl, C_3–C_6 cycloalkyl, C_3–C_6 halocycloalkyl, C_1–C_4 hydroxyalkyl, C_2–C_4 alkoxyalkyl, C_2–C_4 haloalkoxyalkyl, C_2–C_4 alkenyl, C_2–C_4 haloalkenyl, C_3–C_4 alkynyl, C_3–C_4 haloalkynyl, hydroxy, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_2–C_4 alkenyloxy, C_2–C_4 haloalkenyloxy, C_3–C_4 alkynyloxy, C_3–C_4 haloalkynyloxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, C_1–C_4 alkylsulfinyl, C_1–C_4 haloalkylsulfinyl, C_1–C_4 alkylsulfonyl, C_1–C_4 haloalkylsulfonyl, C_2–C_4 alkenylthio, C_2–C_4 haloalkenylthio, C_2–C_4 alkenylsulfinyl, C_2–C_4 haloalkenylsulfinyl, C_2–C_4 alkenylsulfonyl, C_2–C_4 haloalkenylsulfonyl, C_3–C_4 alkynylthio, C_3–C_4 haloalkynylthio, C_3–C_4 alkynylsulfinyl, C_3–C_4 haloalkynylsulfinyl, C_3–C_4 alkynylsulfonyl, C_3–C_4 haloalkynylsulfonyl, C_1–C_4 alkylamino, C_2–C_8 dialkylamino, C_3–C_6 cycloalkylamino, C_4–C_6 (alkyl)cycloalkylamino, C_2–C_6 alkylcarbonyl, C_2–C_6 alkoxycarbonyl, C_2–C_6 alkylaminocarbonyl, C_3–C_8 dialkylaminocarbonyl, C_3–C_6 trialkylsilyl, phenyl, phenoxy and 5- or 6-membered heteroaromatic rings, each phenyl, phenoxy and 5- or 6-membered heteroaromatic ring optionally substituted with one to three substituents independently selected from R^{45}; or

two adjacent R^7 are taken together as -OCH_2O-, -CH_2CH_2O-, -OCH(CH_3)O-, -OC(CH_3)$_2$O-, -OCF_2O-, -CF_2CF_2O-, -OCF_2CF_2O- or -CH=CH–CH=CH-;

R^{15} is H, halogen, C_1–C_4 alkyl, C_1–C_4 haloalkyl, hydroxy, C_1–C_4 alkoxy or C_2–C_4 alkylcarbonyloxy;

R^{16} is H, halogen, C_1–C_4 alkyl or C_1–C_4 haloalkyl; or

R^{15} and R^{16} are taken together as an oxygen atom to form, with the carbon atom to which they are attached, a carbonyl moiety;

R^{20} is H, C_1–C_4 alkyl or C_1–C_3 haloalkyl;

R^{21} is H, C_1–C_4 alkyl or C_1–C_3 haloalkyl;

R^{22} and R^{23} are independently H or C_1–C_4 alkyl;

R^{24} is H, C_1–C_4 alkyl optionally substituted with 1–2 R^{30}, C_2–C_4 alkenyl optionally substituted with 1–2 R^{31}, or C_2–C_4 alkynyl optionally substituted with 1–2 R^{32}; or R^{24} is C(=O)R^{33}, nitro, OR^{34}, S(O)$_2R^{35}$, N(R^{36})R^{37} or N=C(R^{62})R^{63};

R^{25} is H, C_1–C_4 alkyl optionally substituted with 1–2 R^{30} or C(=O)R^{33}; or

R^{24} and R^{25} are taken together as a radical selected from -(CH_2)$_4$-, -(CH_2)$_5$-, -CH_2CH=$CHCH_2$- and -(CH_2)$_2$O(CH_2)$_2$-, each radical optionally substituted with 1–2 R^{38}; or

R^{24} and R^{25} are taken together as $=C(R^{39})N(R^{40})R^{41}$ or $=C(R^{42})OR^{43}$;

each R^{30}, R^{31} and R^{32} is independently halogen, C_1–C_3 alkoxy, C_1–C_3 haloalkoxy, C_1–C_3 alkylthio, C_1–C_3 haloalkylthio, amino, C_1–C_3 alkylamino, C_2–C_4 dialkylamino or C_2–C_4 alkoxycarbonyl;

each R^{33} is independently H, C_1–C_{14} alkyl, C_1–C_3 haloalkyl, C_1–C_4 alkoxy, phenyl, phenoxy or benzyloxy;

R^{34} is H, C_1–C_4 alkyl, C_1–C_3 haloalkyl or $CHR^{66}C(O)OR^{67}$;

R^{35} is C_1–C_4 alkyl or C_1–C_3 haloalkyl;

R^{36} is H, C_1–C_4 alkyl or $C(=O)R^{64}$;

R^{37} is H or C_1–C_4 alkyl;

each R^{38} is independently halogen, C_1–C_3 alkyl, C_1–C_3 alkoxy, C_1–C_3 haloalkoxy, C_1–C_3 alkylthio, C_1–C_3 haloalkylthio, amino, C_1–C_3 alkylamino, C_2–C_4 dialkylamino or C_2–C_4 alkoxycarbonyl;

R^{39} is H or C_1–C_4 alkyl;

R^{40} and R^{41} are independently H or C_1–C_4 alkyl; or

R^{40} and R^{41} are taken together as $-(CH_2)_4-$, $-(CH_2)_5-$, $-CH_2CH=CHCH_2-$ or $-(CH_2)_2O(CH_2)_2-$;

R^{42} is H or C_1–C_4 alkyl;

R^{43} is C_1–C_4 alkyl;

each R^{45} is independently halogen, cyano, nitro, C_1–C_4 alkyl, C_1–C_4 haloalkyl, C_3–C_6 cycloalkyl, C_3–C_6 halocycloalkyl, C_2–C_4 alkenyl, C_2–C_4 haloalkenyl, C_3–C_4 alkynyl, C_3–C_4 haloalkynyl, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, C_1–C_4 alkylsulfinyl, C_1–C_4 alkylsulfonyl, C_1–C_4 alkylamino, C_2–C_8 dialkylamino, C_3–C_6 cycloalkylamino, C_4–C_6 (alkyl)cycloalkylamino, C_2–C_4 alkylcarbonyl, C_2–C_6 alkoxycarbonyl, C_2–C_6 alkylaminocarbonyl, C_3–C_8 dialkylaminocarbonyl or C_3–C_6 trialkylsilyl;

R^{62} is H, C_1–C_4 alkyl or phenyl optionally substituted with 1–3 R^{65};

R^{63} is H or C_1–C_4 alkyl; or

R^{62} and R^{63} are taken together as $-(CH_2)_4-$ or $-(CH_2)_5-$;

R^{64} is H, C_1–C_{14} alkyl, C_1–C_3 haloalkyl, C_1–C_4 alkoxy, phenyl, phenoxy or benzyloxy;

each R^{65} is independently CH_3, Cl or OCH_3;

R^{66} is H, C_1–C_4 alkyl or C_1–C_4 alkoxy;

R^{67} is H, C_1–C_4 alkyl or benzyl;

j is 0 or 1; and

k is 0 or 1;

provided that:

(a) when k is 0, then j is 0;

(b) when R^2 is CH_2OR^a wherein R^a is H, optionally substituted alkyl or benzyl, then R^3 is other than cyano;

(c) when R^1 is phenyl substituted by Cl in each of the meta positions, the phenyl is also substituted by R^7 in the para position;

(d) when R^1 is phenyl substituted by R^7 in the para position, said R^7 is other than *tert*-butyl, cyano or optionally substituted phenyl;

(e) when R^1 is cyclopropyl or isopropyl optionally substituted with 1–5 R^6, then R is other than $C(=W)N(R^b)S(O)_2$-R^c-R^d wherein W is O, S, NR^e or NOR^e; R^b is hydrogen, C_1–C_4 alkyl, C_2–C_6 alkenyl or C_2–C_6 alkynyl; R^c is a direct bond or CHR^f, O, NR^e or NOR^e; R^d is an optionally substituted heterocyclic or carbocyclic aromatic radical having 5 to 6 ring atoms, the radical being optionally condensed with an aromatic or nonaromatic 5- or 6-membered ring; each R^e is independently H, C_1–C_3 alkyl, C_1–C_3 haloalkyl or phenyl; and R^f is H, C_1–C_3 alkyl or phenyl; and

(f) the compound of Formula **I** is other than diethyl 6-amino-5-nitro-2-phenyl-4-pyrimidinemalonate.

More particularly, this invention pertains to a compound of Formula **I**, including all geometric and stereoisomers, *N*-oxides or agriculturally suitable salts thereof. This invention also relates to a herbicidal composition comprising a herbicidally effective amount of a compound of Formula **I** and at least one of a surfactant, a solid diluent or a liquid diluent. This invention further relates to a method for controlling the growth of undesired vegetation comprising contacting the vegetation or its environment with a herbicidally effective amount of a compound of Formula **I** (e.g., as a composition described herein). This invention also relates to a herbicidal mixture comprising a herbicidally effective amount of a compound of Formula **I** and an effective amount of at least one additional active ingredient selected from the group consisting of an other herbicide and a herbicide safener. This invention further relates to a herbicidal composition comprising a herbicidally effective amount of a compound of Formula **I**, an effective amount of at least one additional active ingredient selected from the group consisting of an other herbicide and a herbicide safener, and at least one of a surfactant, a solid diluent or a liquid diluent.

DETAILS OF THE INVENTION

As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having" or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a composition, process, method, article, or apparatus that comprises a list of elements is not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such composition, process, method, article, or apparatus. Further, unless expressly stated to the contrary, "or" refers to an inclusive or and not to an exclusive or. For example, a condition A or B is satisfied by any one of the following: A is

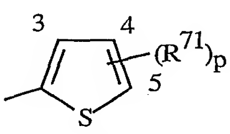
true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

Also, the indefinite articles "a" and "an" preceding an element or component of the invention are intended to be nonrestrictive regarding the number of instances (i.e. occurrences) of the element or component. Therefore "a" or "an" should be read to include one or at least one, and the singular word form of the element or component also includes the plural unless the number is obviously meant to be singular.

In the above recitations, the term "alkyl", used either alone or in compound words such as "alkylthio" or "haloalkyl" includes straight-chain or branched alkyl, such as, methyl, ethyl, *n*-propyl, *i*-propyl, or the different butyl, pentyl or hexyl isomers. "Alkenyl" includes straight-chain or branched alkenes such as ethenyl, 1-propenyl, 2-propenyl, and the different butenyl, pentenyl and hexenyl isomers. "Alkenyl" also includes polyenes such as 1,2-propadienyl and 2,4-hexadienyl. "Alkynyl" includes straight-chain or branched alkynes such as ethynyl, 1-propynyl, 2-propynyl and the different butynyl, pentynyl and hexynyl isomers. "Alkynyl" can also include moieties comprised of multiple triple bonds such as 2,5-hexadiynyl. "Alkoxy" includes, for example, methoxy, ethoxy, *n*-propyloxy, isopropyloxy and the different butoxy, pentoxy and hexyloxy isomers. "Alkoxyalkyl" denotes alkoxy substitution on alkyl. Examples of "alkoxyalkyl" include CH_3OCH_2, $CH_3OCH_2CH_2$, $CH_3CH_2OCH_2$ and $CH_3CH_2OCH_2CH_2$. "Alkenyloxy" includes straight-chain or branched alkenyloxy moieties. Examples of "alkenyloxy" include $H_2C{=}CHCH_2O$, $(CH_3)CH{=}CHCH_2O$ and $CH_2{=}CHCH_2CH_2O$. "Alkynyloxy" includes straight-chain or branched alkynyloxy moieties. Examples of "alkynyloxy" include $HC{\equiv}CCH_2O$ and $CH_3C{\equiv}CCH_2O$. "Alkylthio" includes branched or straight-chain alkylthio moieties such as methylthio, ethylthio, and the different propylthio and butylthio isomers. "Alkylsulfinyl" includes both enantiomers of an alkylsulfinyl group. Examples of "alkylsulfinyl" include $CH_3S(O)$, $CH_3CH_2S(O)$, $CH_3CH_2CH_2S(O)$, $(CH_3)_2CHS(O)$ and the different butylsulfinyl isomers. Examples of "alkylsulfonyl" include $CH_3S(O)_2$, $CH_3CH_2S(O)_2$, $CH_3CH_2CH_2S(O)_2$, $(CH_3)_2CHS(O)_2$ and the different butylsulfonyl isomers. "Alkylamino", "dialkylamino", "alkenylthio", "alkenylsulfinyl", "alkenylsulfonyl", "alkynylthio", "alkynylsulfinyl", "alkynylsulfonyl", and the like, are defined analogously to the above examples. "Cycloalkyl" includes, for example, cyclopropyl, cyclobutyl, cyclopentyl, and cyclohexyl. Examples of "cycloalkylalkyl" include cyclopropylmethyl, cyclopentylethyl, and other cycloalkyl moieties bonded to straight-chain or branched alkyl groups. "Alkylcycloalkyl" denotes alkyl substitution on a cycloalkyl moiety. Examples include 4-methylcyclohexyl and 3-ethylcyclopentyl. The term "heteroaromatic ring" includes fully aromatic heterocycles. Aromatic indicates that each of the ring atoms is essentially in the same plane and has a *p*-orbital perpendicular to the ring plane, and in which $(4n + 2)$ π electrons, when n is 0 or a positive integer, are associated

with the ring to comply with Hückel's rule. The term carbocyclic aromatic radical is synonymous with the term isocyclic aromatic radical. A wide variety of synthetic methods are known in the art to enable preparation of aromatic heterocyclic rings; for extensive reviews see the eight volume set of *Comprehensive Heterocyclic Chemistry*, A. R. Katritzky and C. W. Rees editors-in-chief, Pergamon Press, Oxford, 1984 and the twelve volume set of *Comprehensive Heterocyclic Chemistry II*, A. R. Katritzky, C. W. Rees and E. F. V. Scriven editors-in-chief, Pergamon Press, Oxford, 1996. The 5- and 6-membered heteroaromatic rings described for R^7 typically comprise 1 to 4 heteroatom ring members, the heteroatom members selected from 0–4 N, 0–1 O and 0–1 S atoms. Exhibit 1 shows examples of heteroaromatic rings; H-1 through H-55 are to be construed as illustrative rather than limiting of the heteroaromatic rings within the scope of the present invention.

Exhibit 1



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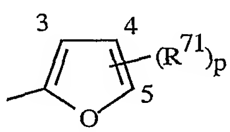

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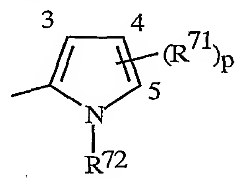

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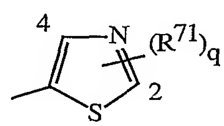

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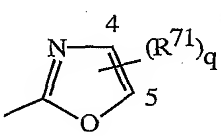

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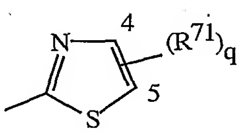

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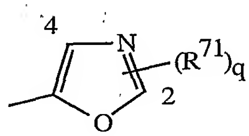

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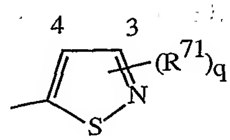

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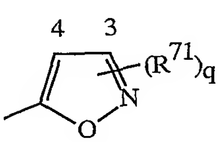

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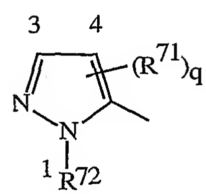

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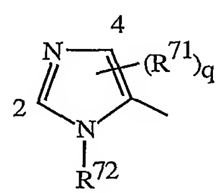

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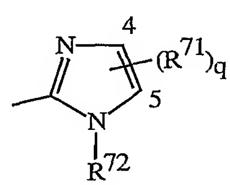

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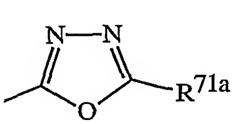

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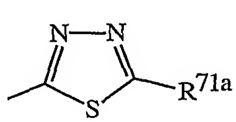

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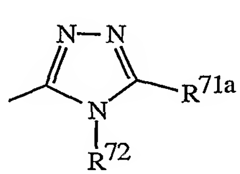

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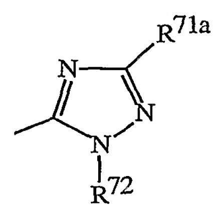

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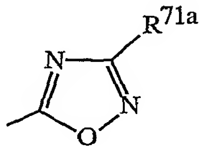

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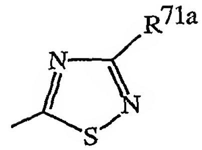

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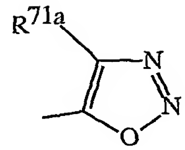

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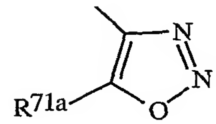

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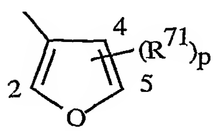

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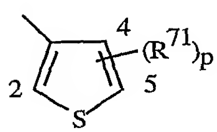

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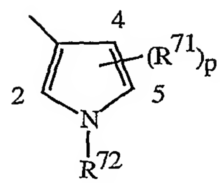

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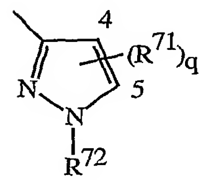

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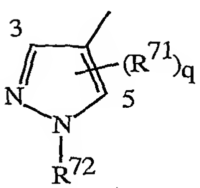

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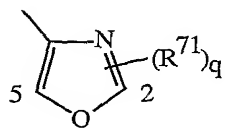

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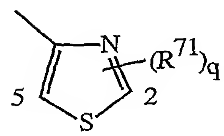

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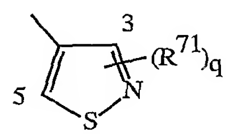

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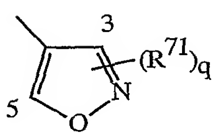

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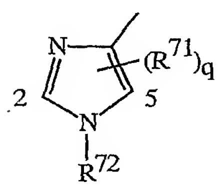

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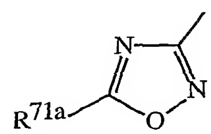

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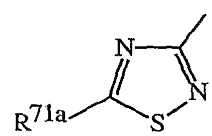

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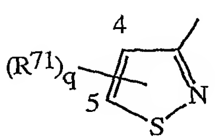

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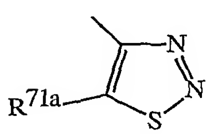

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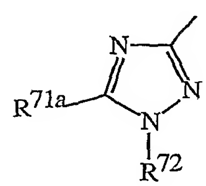

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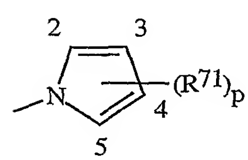

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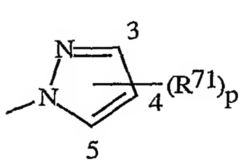

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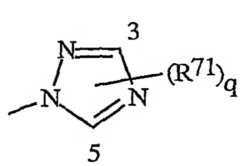

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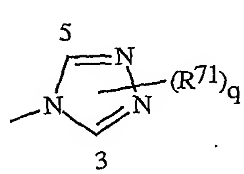

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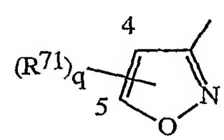

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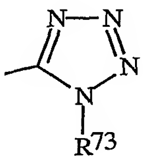 ,

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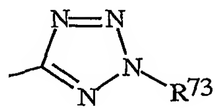 ,

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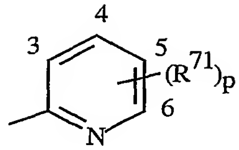 ,

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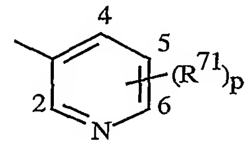 ,

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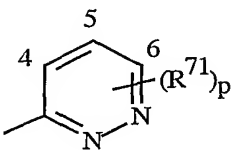 ,

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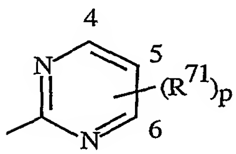 ,

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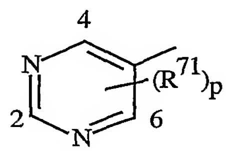 ,

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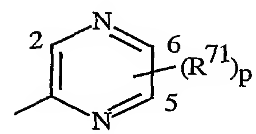 ,

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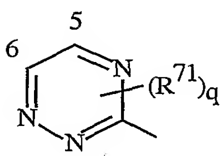 ,

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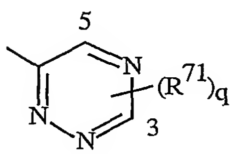 ,

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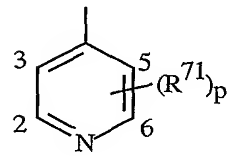 ,

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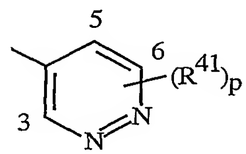 ,

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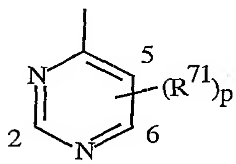 ,

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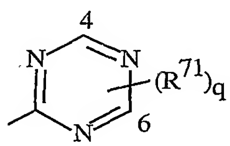
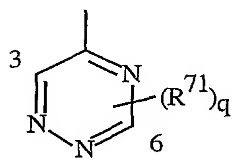
 or

H-54

 ;

H-55

wherein

each R^{71} is independently R^{45};

R^{71a}, R^{72} and R^{73} are independently H or R^{45};

p is an integer from 0 to 3; and

q is an integer from 0 to 2.

References herein to R^7 groups H-1 through H-55 refer to those shown in Exhibit 1.

One skilled in the art will appreciate that not all nitrogen-containing heterocycles can form *N*-oxides since the nitrogen requires an available lone pair of electrons for oxidation to the oxide; one skilled in the art will recognize those nitrogen containing heterocycles which can form *N*-oxides. One skilled in the art will also recognize that tertiary amines can form *N*-oxides. Synthetic methods for the preparation of *N*-oxides of heterocycles and tertiary amines are very well known by one skilled in the art including the oxidation of heterocycles and tertiary amines with peroxy acids such as peracetic and *m*-chloroperbenzoic acid (MCPBA), hydrogen peroxide, alkyl hydroperoxides such as *t*-butyl hydroperoxide, sodium perborate, and dioxiranes such as dimethydioxirane. These methods for the preparation of

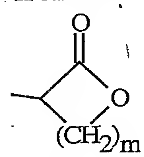
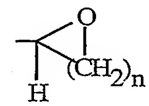
N-oxides have been extensively described and reviewed in the literature, see for example: T. L. Gilchrist in *Comprehensive Organic Synthesis*, vol. 7, pp 748–750, S. V. Ley, Ed., Pergamon Press; M. Tisler and B. Stanovnik in *Comprehensive Heterocyclic Chemistry*, vol. 3, pp 18–20, A. J. Boulton and A. McKillop, Eds., Pergamon Press; M. R. Grimmett and B. R. T. Keene in *Advances in Heterocyclic Chemistry*, vol. 43, pp 149–161, A. R. Katritzky, Ed., Academic Press; M. Tisler and B. Stanovnik in *Advances in Heterocyclic Chemistry*, vol. 9, pp 285–291, A. R. Katritzky and A. J. Boulton, Eds., Academic Press; and G. W. H. Cheeseman and E. S. G. Werstiuk in *Advances in Heterocyclic Chemistry*, vol. 22, pp 390–392, A. R. Katritzky and A. J. Boulton, Eds., Academic Press.

The term "halogen", either alone or in compound words such as "haloalkyl", includes fluorine, chlorine, bromine or iodine. Further, when used in compound words such as "haloalkyl", said alkyl may be partially or fully substituted with halogen atoms which may be the same or different. Examples of "haloalkyl" include F_3C, $ClCH_2$, CF_3CH_2 and CF_3CCl_2. The terms "haloalkenyl", "haloalkynyl", "haloalkoxy", "haloalkylthio", and the like, are defined analogously to the term "haloalkyl". Examples of "haloalkenyl" include $(Cl)_2C{=}CHCH_2$ and $CF_3CH_2CH{=}CHCH_2$. Examples of "haloalkynyl" include $HC{\equiv}CCHCl$, $CF_3C{\equiv}C$, $CCl_3C{\equiv}C$ and $FCH_2C{\equiv}CCH_2$. Examples of "haloalkoxy" include CF_3O, CCl_3CH_2O, $HCF_2CH_2CH_2O$ and CF_3CH_2O. Examples of "haloalkylthio" include CCl_3S, CF_3S, CCl_3CH_2S and $ClCH_2CH_2CH_2S$. Examples of "haloalkylsulfinyl" include $CF_3S(O)$, $CCl_3S(O)$, $CF_3CH_2S(O)$ and $CF_3CF_2S(O)$. Examples of "haloalkylsulfonyl" include $CF_3S(O)_2$, $CCl_3S(O)_2$, $CF_3CH_2S(O)_2$ and $CF_3CF_2S(O)_2$.

The total number of carbon atoms in a substituent group is indicated by the "C_i–C_j" prefix where i and j are numbers from 1 to 14. For example, C_1–C_3 alkylsulfonyl designates methylsulfonyl through propylsulfonyl; C_2 alkoxyalkyl designates CH_3OCH_2; C_3 alkoxyalkyl designates, for example, $CH_3CH(OCH_3)$, $CH_3OCH_2CH_2$ or $CH_3CH_2OCH_2$; and C_4 alkoxyalkyl designates the various isomers of an alkyl group substituted with an alkoxy group containing a total of four carbon atoms, examples including $CH_3CH_2CH_2OCH_2$ and $CH_3CH_2OCH_2CH_2$. Examples of "alkylcarbonyl" include $C(O)CH_3$, $C(O)CH_2CH_2CH_3$ and $C(O)CH(CH_3)_2$. Examples of "alkoxycarbonyl" include $CH_3OC(=O)$, $CH_3CH_2OC(=O)$, $CH_3CH_2CH_2OC(=O)$, $(CH_3)_2CHOC(=O)$ and the different butoxy- or pentoxycarbonyl isomers. In the above recitations, when a compound of Formula **I** is comprised of one or more heterocyclic rings, all substituents are attached to these rings through any available carbon or nitrogen by replacement of a hydrogen on said carbon or nitrogen.

When a compound is substituted with a substituent bearing a subscript (e.g., $(R^d)_{1-3}$) that indicates the number of instances (i.e. occurrences) of said substituent can vary or the substituent is preceded with a numeric range (e.g., 1–3 R^d) indicating the number of instances of said subsituent can vary, then when the number of said instances is greater than

1, each instance is independently selected from the group of radicals defined for the substituent. Further, when the subscript indicates a range, e.g., $(R^d)_{i-j}$, then the number of substituent instances may be selected from the integers between i and j inclusive.

"$-CH[C(O)O(CH_2)_m]$" means  ; "$-CH[O(CH_2)_n]$" means .

When a group contains a substituent which can be hydrogen, for example R^{15} or R^{34}, then, when this substituent is taken as hydrogen, it is recognized that this is equivalent to said group being unsubstituted.

Compounds of this invention can exist as one or more stereoisomers. The various stereoisomers include enantiomers, diastereomers, atropisomers and geometric isomers. One skilled in the art will appreciate that one stereoisomer may be more active and/or may exhibit beneficial effects when enriched relative to the other stereoisomer(s) or when separated from the other stereoisomer(s). Additionally, the skilled artisan knows how to separate, enrich, and/or to selectively prepare said stereoisomers. Accordingly, the present invention comprises compounds selected from Formula **I**, *N*-oxides and agriculturally suitable salts thereof. The compounds of the invention may be present as a mixture of stereoisomers, individual stereoisomers, or as an optically active form.

The compounds of Formula **I** wherein R is CO_2H (i.e. a carboxylic acid function) are believed to be the compounds that bind to an active site on a plant enzyme or receptor causing herbicidal effect on the plant. Other compounds of Formula **I** wherein the substituent R is a group that can be transformed within plants or the environment to a carboxylic acid function (i.e. CO_2H) provide similar herbicidal effects and are within the scope of the present invention. Therefore "a herbicidally effective derivative of CO_2H" when used to describe the substituent R in Formula **I** is defined as any salt, ester, carboxamide, acyl hydrazide, imidate, thioimidate, amidine, acyl halide, acyl cyanide, acid anhydride, ether, acetal, orthoester, carboxaldehyde, oxime, hydrazone, thioacid, thioester, dithiolester, nitrile or any other carboxylic acid derivative known in the art which does not extinguish the herbicidal activity of the compound of Formula **I** and is or can be hydrolyzed, oxidized, reduced or otherwise metabolized in plants or soil to provide the carboxylic acid function, which depending upon pH, is in the dissociated or the undissociated form.

Agriculturally suitable salts of the compounds of the invention are salts formed by contact with acids or bases or through ion exchange such that the derived salts retain sufficient water solubility for bioavailability and thus herbicidal efficacy and that the counterions of the salts are suitable for use in agriculture. The agriculturally suitable salts of the compounds of the invention include acid-addition salts with inorganic or organic acids such as hydrobromic, hydrochloric, nitric, phosphoric, sulfuric, acetic, butyric, fumaric, lactic, maleic, malonic, oxalic, propionic, salicylic, tartaric, 4-toluenesulfonic or valeric

acids. The agriculturally suitable salts of the compounds of the invention also include those formed with strong bases (e.g., hydroxides of sodium, potassium, lithium or quaternary ammonium) or amines. One skilled in the art recognizes that because in the environment and under physiological conditions salts of the compounds of the invention are in equilibrium with their corresponding nonsalt forms, agriculturally suitable salts share the biological utility of the nonsalt forms.

Particularly useful are agriculturally suitable salts of compounds of Formula **I** wherein R is CO_2H (including wherein R^2 is CO_2H) formed with strong bases or amines. As is well known in the art, contact of a carboxylic acid group (CO_2H) with a base causes deprotonation to give the corresponding carboxylate ion ($CO_2^{\ominus}$) and a typically positively charged counterion derived from the base. An extensive range of counterions form agriculturally suitable salts of compounds of Formula **I** wherein R is CO_2H, as most of the derived salts have sufficient water solubility for bioavailability. Illustrative and of particular note are salts of compounds of Formula **I** in which R is CO_2H wherein the counterion ion is an alkali metal cation such as lithium, sodium or potassium, quarternary ammonium such as tetramethylammonium, ternary sulfonium such as trimethylsulfonium, or derived from an amine such as dimethylamine, diethanolamine (diolamine), triethanolamine (trolamine).

Also particularly useful are ester and thioester derivatives of CO_2H as R in the compounds of Formula **I**. As is well known in the art, ester groups (i.e. CO_2R^{AL}) result from condensation of a carboxylic acid function (CO_2H) with an alcohol (i.e. $R^{AL}OH$) wherein R^{AL} is the radical derived from the alcohol; a wide range of methods are known to prepare such esters. Analogously, thioester groups of formula $C(O)SR^{AL}$ may be conceptually viewed as the condensation product of a carboxylic acid function with a thioalcohol (often called a mercaptan) of formula $R^{AL}SH$; a variety of methods are known to prepare such thioesters. As compounds of Formula **I** wherein R is CO_2H are herbicidally active and their derived esters and thioesters are susceptible to hydrolysis (to R being CO_2H) particularly in the presence of hydrolytic enzymes, the compounds of Formula **I** wherein R^1 is an ester (i.e. CO_2R^{AL}) or thioester (i.e. $C(O)SR^{AL}$) are generally useful as herbicides. Of the herbicidally effective derivatives of CO_2H, the ester and thioester derivatives, particularly ester derivatives, are among the most conveniently prepared and useful. If the radical R^{AL} has more than one OH or SH function, the radical may then be condensed with more than one pyrimidine ring system of Formula **I** having CO_2H as R. As the derived multiply esterified derivatives can be hydrolyzed to the compound of Formula **I** having CO_2H as R, said multiply esterified derivatives are among the herbicidally effective derivatives of CO_2H. Illustrative and of note are ester and thioester compounds of Formula **I** in which R being CO_2H is esterified with methanol, ethanol, butanol, 2-butoxyethanol, 2-ethylhexanol, isopropanol, 2-methylpropanol (isobutanol), octanol isomers (isoctanol) and ethanethiol to form methyl, ethyl, butyl, 2-butoxyethyl, 2-ethylhexyl, isopropyl,

2-methypropyl, isoctyl and ethylthio esters, respectively. Of particular note are the methyl and ethyl esters.

Embodiments of the present invention include:

Embodiment 1. A compound of Formula **I** wherein j is 0.

Embodiment 2. A compound of Formula **I** wherein k is 0.

Embodiment 3. A compound of Formula **I** wherein R^{15} is H.

Embodiment 4. A compound of Embodiment 3 wherein R^{16} is H.

Embodiment 5. A compound of Formula **I** wherein

R is CO_2R^{12}, CH_2OR^{13}, $CH(OR^{46})(OR^{47})$, CHO, $C(=NOR^{14})H$, $C(=NNR^{48}R^{49})H$, $C(=O)N(R^{18})R^{19}$, $C(=S)OR^{50}$, $C(=O)SR^{51}$, $C(=S)SR^{52}$ or $C(=NR^{53})YR^{54}$;

R^{12} is H, $-CH[C(O)O(CH_2)_m]$, $-N=C(R^{55})R^{56}$; or a radical selected from C_1–C_{14} alkyl, C_3–C_{12} cycloalkyl, C_4–C_{12} alkylcycloalkyl, C_4–C_{12} cycloalkylalkyl, C_2–C_{14} alkenyl, C_2–C_{14} alkynyl and phenyl, each radical optionally substituted with 1–3 R^{27}; or

R^{12} is a divalent radical linking the carboxylic ester function CO_2R^{12} of each of two pyrimidine ring systems of Formula **I**, the divalent radical selected from $-CH_2-$, $-(CH_2)_2-$, $-(CH_2)_3-$ and $-CH(CH_3)CH_2-$;

R^{13} is H, C_1–C_{10} alkyl optionally substituted with 1–3 R^{28}, or benzyl;

R^{14} is H, C_1–C_4 alkyl, C_1–C_4 haloalkyl or benzyl;

R^{18} is H, C_1–C_4 alkyl, hydroxy, C_1–C_4 alkoxy or $S(O)_2R^{57}$;

R^{19} is H or C_1–C_4 alkyl;

each R^{27} is independently halogen, cyano, hydroxycarbonyl, C_2–C_4 alkoxycarbonyl, hydroxy, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, amino, C_1–C_4 alkylamino, C_2–C_4 dialkylamino, $-CH[O(CH_2)_n]$ or phenyl optionally substituted with 1–3 R^{44}; or

two R^{27} are taken together as -OC(O)O- or $-O(C(R^{58})(R^{58}))_{1-2}O-$; or

two R^{27} are taken together as an oxygen atom to form, with the carbon atom to which they are attached, a carbonyl moiety;

each R^{28} is independently halogen, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, amino, C_1–C_4 alkylamino or C_2–C_4 dialkylamino; or

two R^{28} are taken together as an oxygen atom to form, with the carbon atom to which they are attached, a carbonyl moiety;

each R^{44} is independently halogen, C_1–C_4 alkyl, C_1–C_3 haloalkyl, hydroxy, C_1–C_4 alkoxy, C_1–C_3 haloalkoxy, C_1–C_3 alkylthio, C_1–C_3 haloalkylthio, amino, C_1–C_3 alkylamino, C_2–C_4 dialkylamino or nitro;

R^{46} and R^{47} are independently C_1–C_4 alkyl or C_1–C_3 haloalkyl; or

R^{46} and R^{47} are taken together as $-CH_2CH_2-$, $-CH_2CH(CH_3)-$ or $-(CH_2)_3-$;

R^{48} is H, C_1–C_4 alkyl, C_1–C_4 haloalkyl, C_2–C_4 alkylcarbonyl, C_2–C_4 alkoxycarbonyl or benzyl;

R^{49} is H, C_1–C_4 alkyl or C_1–C_4 haloalkyl;

R^{50}, R^{51} and R^{52} are H; or a radical selected from C_1–C_{14} alkyl, C_3–C_{12} cycloalkyl, C_4–C_{12} alkylcycloalkyl, C_4–C_{12} cycloalkylalkyl, C_2–C_{14} alkenyl and C_2–C_{14} alkynyl, each radical optionally substituted with 1–3 R^{27};

Y is O, S or NR^{61};

R^{53} is H, C_1–C_3 alkyl, C_1–C_3 haloalkyl, C_2–C_4 alkoxyalkyl, OH or C_1–C_3 alkoxy;

R^{54} is C_1–C_3 alkyl, C_1–C_3 haloalkyl or C_2–C_4 alkoxyalkyl; or

R^{53} and R^{54} are taken together as $-(CH_2)_2-$, $-CH_2CH(CH_3)-$ or $-(CH_2)_3-$;

R^{55} and R^{56} are independently C_1–C_4 alkyl;

R^{57} is C_1–C_4 alkyl, C_1–C_3 haloalkyl or $NR^{59}R^{60}$;

each R^{58} is independently selected from H and C_1–C_4 alkyl;

R^{59} and R^{60} are independently H or C_1–C_4 alkyl;

R^{61} is H, C_1–C_3 alkyl, C_1–C_3 haloalkyl or C_2–C_4 alkoxyalkyl;

m is an integer from 2 to 3; and

n is an integer from 1 to 4.

Embodiment 6. A compound of Formula **I** wherein when R^1 is optionally substituted cyclopropyl, then R^2 is other than alkoxyalkyl or alkylthioalkyl.

Embodiment 7. A compound of Formula **I** wherein R^2 is other than alkoxyalkyl or alkylthioalkyl.

Embodiment 8. A compound of Embodiment 5 wherein

R^2 is CO_2R^{12}, CH_2OR^{13}, $CH(OR^{46})(OR^{47})$, CHO, $C(=NOR^{14})H$, $C(=NNR^{48}R^{49})H$, $(O)_jC(R^{15})(R^{16})CO_2R^{17}$, $C(=O)N(R^{18})R^{19}$, $C(=S)OR^{50}$, $C(=O)SR^{51}$, $C(=S)SR^{52}$ or $C(=NR^{53})YR^{54}$;

R^{17} is C_1–C_{10} alkyl optionally substituted with 1–3 R^{29}, or benzyl; and

each R^{29} is independently halogen, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, amino, C_1–C_4 alkylamino or C_2–C_4 dialkylamino.

Embodiment 9. A compound of Embodiment 8 wherein when R^3 is CH_2OR^{13}, then R^{13} is other than alkyl.

Embodiment 10. A compound of Embodiment 8 wherein when R^3 is CH_2OR^{13}, then R^{13} is other than optionally substituted alkyl.

Embodiment 11. A compound of Embodiment 8 wherein R^3 is other than CH_2OR^{13}.

Embodiment 12. A compound of Embodiment 8 wherein j is 0.

Embodiment 13. A compound of Embodiment 12 wherein R^2 is CO_2R^{12}, CH_2OR^{13}, CHO or $CH_2CO_2R^{17}$.

Embodiment 14. A compound of Embodiment 13 wherein R^2 is CO_2R^{12}.

Embodiment 15. A compound of Embodiment 14 wherein R^{12} is H, C_1–C_8 alkyl or C_1 alkyl substituted with phenyl optionally substituted with 1–3 R^{44}.

Embodiment 16. A compound of Embodiment 15 wherein R^{12} is H, C_1–C_4 alkyl or C_1 alkyl substituted with phenyl optionally substituted with 1–3 R^{44}.

Embodiment 17. A compound of Embodiment 16 wherein R^{12} is H, C_1–C_4 alkyl or benzyl.

Embodiment 18. A compound of Formula **I** wherein R^2 is CO_2H, an agriculturally suitable salt or an ester or thioester derivative thereof.

Embodiment 19. A compound of Embodiment 18 wherein R^2 is CO_2H, an agriculturally suitable salt or an ester derivative thereof.

Embodiment 20. A compound of Formula **I** wherein R^1 is cyclopropyl optionally substituted with 1–5 R^5.

Embodiment 21. A compound of Formula **I** wherein R^1 is isopropyl optionally substituted with 1–5 R^6.

Embodiment 22. A compound of Formula **I** wherein R^1 is phenyl optionally substituted with 1–3 R^7.

Embodiment 23. A compound of Formula **I** wherein R^1 is cyclopropyl optionally substituted with 1–5 R^5 or isopropyl optionally substituted with 1–5 R^6.

Embodiment 24. A compound of Formula **I** wherein R^1 is cyclopropyl optionally substituted with 1–5 R^5 or phenyl optionally substituted with 1–3 R^7.

Embodiment 25. A compound of Formula **I** wherein R^1 is isopropyl optionally substituted with 1–5 R^6 or phenyl optionally substituted with 1–3 R^7.

Embodiment 26. A compound of Formula **I** wherein R^1 is other than cyclopropyl.

Embodiment 27. A compound of Formula **I** wherein R^1 is cyclopropyl optionally substituted with 1–2 R^6 or phenyl optionally substituted with 1–3 R^7.

Embodiment 28. A compound of Embodiment 27 wherein R^1 is cyclopropyl optionally substituted with 1–2 R^6.

Embodiment 29. A compound of Embodiment 27 wherein R^1 is cyclopropyl or phenyl optionally substituted with 1–3 R^7.

Embodiment 30. A compound of Embodiment 28 wherein R^1 is cyclopropyl.

Embodiment 31. A compound of Embodiment 27 wherein R^1 is phenyl optionally substituted with 1–3 R^7.

Embodiment 32. A compound of Embodiment 27 wherein R^1 is cyclopropyl or phenyl substituted with a R^7 radical in the para position and optionally with 1–2 R^7 in other positions.

Embodiment 33. A compound of Embodiment 32 wherein R^1 is cyclopropyl or phenyl substituted with a halogen, methyl or methoxy radical in the para position and optionally with 1–2 radicals selected from halogen and methyl in other positions.

Embodiment 34. A compound of Embodiment 33 wherein R^1 is cyclopropyl or phenyl substituted with a halogen radical in the para position and optionally with 1–2 radicals selected from halogen and methyl in other positions.

Embodiment 35. A compound of Embodiment 34 wherein R^1 is cyclopropyl or phenyl substituted with a Br or Cl radical in the para position and optionally with 1–2 radicals selected from halogen and methyl in other positions.

Embodiment 36. A compound of Embodiment 35 wherein R^1 is phenyl substituted with a Br or Cl radical in the para position and optionally with 1–2 radicals selected from halogen and methyl in other positions.

Embodiment 37. A compound of Embodiment 35 wherein R^1 is cyclopropyl or phenyl substituted with a Br or Cl radical in the para position.

Embodiment 38. A compound of Embodiment 37 wherein R^1 is phenyl substituted with a Br or Cl radical in the para position.

Embodiment 39. A compound of Formula **I** wherein R^7 is other than cyano.

Embodiment 40. A compound of Formula **I** wherein R^7 selected from other than optionally substituted phenyl, phenoxy and 5- and 6-membered heteroaromatic rings.

Embodiment 41. A compound of Formula **I** wherein each R^7 is independently selected from halogen, C_1–C_2 alkyl, C_1–C_2 haloalkyl, C_1–C_2 alkoxy or C_1–C_2 haloalkoxy; or two adjacent R^7 are taken together as $-OCH_2O-$, $-CH_2CH_2O-$, $-OCH(CH_3)O-$, $-OC(CH_3)_2O-$, $-OCF_2O-$, $-CF_2CF_2O-$, $-OCF_2CF_2O-$ or $-CH{=}CH{-}CH{=}CH-$.

Embodiment 42. A compound of Embodiment 41 wherein each R^7 is independently selected from halogen, C_1–C_2 alkyl, C_1–C_2 haloalkyl, C_1–C_2 alkoxy or C_1–C_2 haloalkoxy; or two adjacent R^7 are taken together as $-OCH_2O-$, $-CH_2CH_2O-$, $-OCH(CH_3)O-$ or $-OCF_2O-$.

Embodiment 43. A compound of Embodiment 42 wherein each R^7 is independently selected from halogen, C_1–C_2 alkyl, C_1 fluoroalkyl, C_1–C_2 alkoxy or C_1 fluoroalkoxy.

Embodiment 44. A compound of Formula **I** wherein each R^7 is independently selected from halogen, methyl and methoxy.

Embodiment 45. A compound of Embodiment 44 wherein each R^7 is independently selected from halogen and methyl.

Embodiment 46. A compound of Embodiment 45 wherein each R^7 is independently selected from F, Cl and Br.

Embodiment 47. A compound of Embodiment 46 wherein each R^7 is independently selected from Cl and Br.

Embodiment 48. A compound of Formula **I** wherein R^3 is other than cyano.

Embodiment 49. A compound of Formula **I** wherein R^3 is other than nitro.

Embodiment 50. A compound of Formula **I** wherein R^3 is halogen, nitro, OR^{20}, SR^{21} or $N(R^{22})R^{23}$.

Embodiment 51. A compound of Embodiment 50 wherein R^3 is halogen.

Embodiment 52. A compound of Embodiment 51 wherein R^3 is Br or Cl.

Embodiment 53. A compound of Embodiment 52 wherein R^3 is Cl.

Embodiment 54. A compound of Formula **I** wherein R^4 is $-N(R^{24})R^{25}$.

Embodiment 55. A compound of Formula **I** wherein R^{24} is other than $C_2–C_4$ alkynyl optionally substituted with 1–2 R^{32}.

Embodiment 56. A compound of Formula **I** wherein R^{24} is H, $C(O)R^{33}$ or $C_1–C_4$ alkyl optionally substituted with R^{30}; R^{25} is H or $C_1–C_2$ alkyl; or R^{24} and R^{25} are taken together as $=C(R^{39})N(R^{40})R^{41}$.

Embodiment 57. A compound of Embodiment 56 wherein R^{24} is H, $C(O)CH_3$ or $C_1–C_4$ alkyl optionally substituted with R^{30}; and R^{25} is H or $C_1–C_2$ alkyl.

Embodiment 58. A compound of Embodiment 57 wherein R^{24} and R^{25} are independently H or methyl.

Embodiment 59. A compound of Embodiment 58 wherein R^{24} and R^{25} are H.

Embodiment 60. A compound of Formula **I** wherein R^{30} is halogen, methoxy, C_1 fluoroalkoxy, methylthio, C_1 fluoroalkylthio, amino, methylamino, dimethylamino or methoxycarbonyl.

Embodiment 61. A compound of Formula **I** wherein R^{33} is H or $C_1–C_3$ alkyl.

Embodiment 62. A compound of Embodiment 61 wherein R^{33} is CH_3.

Embodiment 63. A compound of Formula **I** wherein R^{39} is H or $C_1–C_2$ alkyl.

Embodiment 64. A compound of Formula **I** wherein R^{40} and R^{41} are independently H or $C_1–C_2$ alkyl.

Embodiment 65. A compound of Formula **I** wherein R^3 is other than OH.

Embodiment 66. A compound of Formula **I** wherein R^3 is other than OR^{20}.

Embodiment 67. A compound of Formula **I** wherein when j is 1, and R^1 is isopropyl substituted with at least one R^6 being halogen, then R^{24} and R^{25} are each H.

Embodiment 68. A compound of Formula **I** wherein when j is 1, R^1 is optionally substituted isopropyl, the R^{24} and R^{25} are each H.

Embodiment 69. A compound of Formula **I** wherein when j is 1, then R^{24} and R^{25} are each H.

Embodiment 70. A compound of Formula **I** wherein when j is 1, then R^6 is other than halogen.

Embodiment 71. A compound of Formula **I** wherein when j is 1, then R^1 is other than optionally substituted isopropyl.

Embodiment 72. A compound of Formula **I** wherein when j is 1, then R^1 is cyclopropyl optionally substituted with 1–5 R^5, isopropyl, or phenyl optionally substituted with 1–3 R^7.

Embodiment 73. A compound of Formula **I** wherein when j is 1, then R^1 is cyclopropyl, isopropyl, or phenyl optionally substituted with 1–3 R^7.

Embodiment 74. A compound of Formula **I** wherein when R^1 is phenyl optionally substituted with 1–3 R^7 then R is other than cyano.

Embodiment 75. A compound of Formula **I** wherein R is other than cyano.

Embodiment 76. A compound of Embodiment 5 wherein when R^1 is phenyl optionally substituted with 1–3 R^7 then R is CO_2R^{12}.

Embodiment 77. A compound of Embodiment 5 wherein R is CO_2R^{12}.

Embodiment 78. A compound of Embodiment 8 wherein when R^1 is phenyl optionally substituted with 1–3 R^7 then R^2 is CO_2R^{12}.

Embodiment 79. A compound of Embodiment 8 wherein R^2 is CO_2R^{12}.

Embodiment 80. A compound of Formula **I** wherein when R^1 is phenyl optionally substituted with 1–3 R^7 then R^{24} is H, $C(=O)R^{33}$, nitro, OR^{34}, $S(O)_2R^{35}$ or $N(R^{36})R^{37}$, and R^{25} is H or $C(=O)R^{33}$.

Embodiment 81. A compound of Formula **I** wherein when R^1 is phenyl optionally substituted with 1–3 R^7 then R^{24} and R^{25} are each H.

Embodiment 82. A compound of Formula **I** wherein R^{24} is H, $C(=O)R^{33}$, nitro, OR^{34}, $S(O)_2R^{35}$ or $N(R^{36})R^{37}$, and R^{25} is H or $C(=O)R^{33}$.

Embodiment 83. A compound of Formula **I** wherein R^{24} and R^{25} are each H.

Embodiment 84. A compound of Formula **I** wherein when R^1 is cyclopropyl or isopropyl optionally substituted with 1–5 R^6, then R is other than $C(=W^1)N(R^{b1})S(O)_2\text{-}R^{cd}$ wherein W comprises at least one atom; R^{b1} comprises at least one atom and R^{cd} comprises at least one atom.

Embodiment 85. A compound of Formula **I** wherein when R^1 is cyclopropyl optionally substituted with 1–5 R^5 or isopropyl optionally substituted with 1–5 R^6, then R is other than $C(=W^1)N(R^{b1})S(O)_2\text{-}R^{cd}$ wherein W comprises at least one atom; R^{b1} comprises at least one atom and R^{cd} comprises at least one atom.

Embodiment 86. A compound of Formula **I** wherein R is other than $C(=W^1)N(R^{b1})S(O)_2\text{-}R^{cd}$ wherein W comprises at least one atom; R^{b1} comprises at least one atom and R^{cd} comprises at least one atom.

Embodiment 87. A compound of Embodiment 5 wherein R^{18} is H, C_1–C_4 alkyl, hydroxy or C_1–C_4 alkoxy.

Embodiment 88. A compound of Embodiment 8 wherein R^{18} is H, C_1–C_4 alkyl, hydroxy or C_1–C_4 alkoxy.

Embodiment 89. A compound of Formula **I** wherein each R^5 and R^6 is independently halogen, C_1–C_2 alkyl or C_1–C_2 haloalkyl.

Embodiment 90. A compound of Formula **I** wherein R^{15} is H, halogen, C_1–C_4 alkyl, C_1–C_4 haloalkyl, hydroxy, C_1–C_4 alkoxy or C_2–C_4 alkylcarbonyloxy.

Embodiment 91. A compound of Formula **I** wherein R^{16} is H, halogen, C_1–C_4 alkyl or C_1–C_4 haloalkyl.

Embodiment 92. A compound of Formula **I** wherein R^{24} is H, C_1–C_4 alkyl optionally substituted with 1–2 R^{30}, C_2–C_4 alkenyl optionally substituted with 1–2 R^{31}, or C_2–C_4 alkynyl optionally substituted with 1–2 R^{32}; or R^{24} is C(=O)R^{33}, nitro, OR^{34}, $S(O)_2R^{35}$ or $N(R^{36})R^{37}$.

Embodiment 93. A compound of Formula **I** wherein each R^{33} is independently H, C_1–C_4 alkyl, C_1–C_3 haloalkyl, C_1–C_4 alkoxy, phenoxy or benzyloxy.

Embodiment 94. A compound of Formula **I** wherein R^{34} is H, C_1–C_4 alkyl or C_1–C_3 haloalkyl.

Embodiment 95. A compound of Formula **I** wherein R^{36} is H or C_1–C_4 alkyl.

Embodiment 96. A compound of Embodiment 5 wherein R^{12} is H; or a radical selected from C_1–C_{14} alkyl, C_3–C_{12} cycloalkyl, C_4–C_{12} alkylcycloalkyl, C_4–C_{12} cycloalkylalkyl, C_2–C_{14} alkenyl and C_2–C_{14} alkynyl, each radical optionally substituted with 1–3 R^{27}; or -N=C(R^{55})R^{56}.

Embodiment 97. A compound of Embodiment 5 wherein each R^{27} is independently halogen, hydroxycarbonyl, C_2–C_4 alkoxycarbonyl, hydroxy, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, amino, C_1–C_4 alkylamino, C_2–C_4 dialkylamino, -CH[O$(CH_2)_n$] or phenyl optionally substituted with 1–3 R^{44}; or two R^{27} are taken together as -OC(O)O- or -O(C(R^{58})(R^{58}))$_{1-2}$O-; or two R^{27} are taken together as an oxygen atom to form, with the carbon atom to which they are attached, a carbonyl moiety.

Embodiment 98. A compound of Embodiment 5 wherein R^{53} is H, C_1–C_3 alkyl, C_1–C_3 haloalkyl or C_2–C_4 alkoxyalkyl.

Combinations of Embodiments 1–98 are illustrated by:

Embodiment A. A compound of Formula **I** wherein

R^2 is CO_2R^{12}, CH_2OR^{13}, CH(OR^{46})(OR^{47}), CHO, C(=NOR^{14})H, C(=NN$R^{48}R^{49}$)H, $(O)_j$C(R^{15})(R^{16})CO_2R^{17}, C(=O)N(R^{18})R^{19}, C(=S)OR^{50}, C(=O)SR^{51}, C(=S)SR^{52} or C(=NR^{53})YR^{54};

R^{12} is H, -CH[C(O)O$(CH_2)_m$], -N=C(R^{55})R^{56}; or a radical selected from C_1–C_{14} alkyl, C_3–C_{12} cycloalkyl, C_4–C_{12} alkylcycloalkyl, C_4–C_{12} cycloalkylalkyl,

C_2–C_{14} alkenyl, C_2–C_{14} alkynyl and phenyl, each radical optionally substituted with 1–3 R^{27}; or

R^{12} is a divalent radical linking the carboxylic ester function CO_2R^{12} of each of two pyrimidine ring systems of Formula **I**, the divalent radical selected from -CH_2-, -$(CH_2)_2$-, -$(CH_2)_3$- and -$CH(CH_3)CH_2$-;

R^{13} is H, C_1–C_{10} alkyl optionally substituted with 1–3 R^{28}, or benzyl;

R^{14} is H, C_1–C_4 alkyl, C_1–C_4 haloalkyl or benzyl;

R^{17} is C_1–C_{10} alkyl optionally substituted with 1–3 R^{29}, or benzyl;

R^{18} is H, C_1–C_4 alkyl, hydroxy, C_1–C_4 alkoxy or $S(O)_2R^{57}$;

R^{19} is H or C_1–C_4 alkyl;

each R^{27} is independently halogen, cyano, hydroxycarbonyl, C_2–C_4 alkoxycarbonyl, hydroxy, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, amino, C_1–C_4 alkylamino, C_2–C_4 dialkylamino, -$CH[O(CH_2)_n]$ or phenyl optionally substituted with 1–3 R^{44}; or

two R^{27} are taken together as -OC(O)O- or -$O(C(R^{58})(R^{58}))_{1-2}O$-; or

two R^{27} are taken together as an oxygen atom to form, with the carbon atom to which they are attached, a carbonyl moiety;

each R^{28} is independently halogen, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, amino, C_1–C_4 alkylamino or C_2–C_4 dialkylamino; or

two R^{28} are taken together as an oxygen atom to form, with the carbon atom to which they are attached, a carbonyl moiety;

each R^{29} is independently halogen, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, amino, C_1–C_4 alkylamino or C_2–C_4 dialkylamino;

each R^{44} is independently halogen, C_1–C_4 alkyl, C_1–C_3 haloalkyl, hydroxy, C_1–C_4 alkoxy, C_1–C_3 haloalkoxy, C_1–C_3 alkylthio, C_1–C_3 haloalkylthio, amino, C_1–C_3 alkylamino, C_2–C_4 dialkylamino or nitro;

R^{46} and R^{47} are independently C_1–C_4 alkyl or C_1–C_3 haloalkyl; or

R^{46} and R^{47} are taken together as -CH_2CH_2-, -$CH_2CH(CH_3)$- or -$(CH_2)_3$-;

R^{48} is H, C_1–C_4 alkyl, C_1–C_4 haloalkyl, C_2–C_4 alkylcarbonyl, C_2–C_4 alkoxycarbonyl or benzyl;

R^{49} is H, C_1–C_4 alkyl or C_1–C_4 haloalkyl;

R^{50}, R^{51} and R^{52} are H; or a radical selected from C_1–C_{14} alkyl, C_3–C_{12} cycloalkyl, C_4–C_{12} alkylcycloalkyl, C_4–C_{12} cycloalkylalkyl, C_2–C_{14} alkenyl and C_2–C_{14} alkynyl, each radical optionally substituted with 1–3 R^{27};

Y is O, S or NR^{61};
R^{53} is H, C_1–C_3 alkyl, C_1–C_3 haloalkyl, C_2–C_4 alkoxyalkyl, OH or C_1–C_3 alkoxy;
R^{54} is C_1–C_3 alkyl, C_1–C_3 haloalkyl or C_2–C_4 alkoxyalkyl; or
R^{53} and R^{54} are taken together as $-(CH_2)_2-$, $-CH_2CH(CH_3)-$ or $-(CH_2)_3-$;
R^{55} and R^{56} are independently C_1–C_4 alkyl;
R^{57} is C_1–C_4 alkyl, C_1–C_3 haloalkyl or $NR^{59}R^{60}$;
each R^{58} is independently selected from H and C_1–C_4 alkyl;
R^{59} and R^{60} are independently H or C_1–C_4 alkyl;
R^{61} is H, C_1–C_3 alkyl, C_1–C_3 haloalkyl or C_2–C_4 alkoxyalkyl;
m is an integer from 2 to 3; and
n is an integer from 1 to 4.

Embodiment B. A compound of Embodiment A wherein R^3 is halogen.

Embodiment C. A compound of Embodiment B wherein R^1 is cyclopropyl or phenyl substituted with a halogen, methyl or methoxy radical in the para position and optionally with 1–2 radicals selected from halogen and methyl in other positions; and R^4 is $-N(R^{24})R^{25}$.

Embodiment D. A compound of Embodiment C wherein R^2 is CO_2R^{12}, CH_2OR^{13}, CHO or $CH_2CO_2R^{17}$.

Embodiment E. A compound of Embodiment D wherein R^{24} is H, $C(O)R^{33}$ or C_1–C_4 alkyl optionally substituted with R^{30}; R^{25} is H or C_1–C_2 alkyl; or R^{24} and R^{25} are taken together as $=C(R^{39})N(R^{40})R^{41}$.

Embodiment F. A compound of Embodiment E wherein R^2 is CO_2R^{12}; and R^{24} and R^{25} are H.

Embodiment G. A compound of Embodiment F wherein R^{12} is H, C_1–C_4 alkyl or benzyl.

Specific embodiments include compounds of Formula **I** selected from the group consisting of:

methyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate,
ethyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate,
phenylmethyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate,
6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylic acid monosodium salt,
methyl 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylate,
phenylmethyl 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylate,
6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylic acid monosodium salt,
ethyl 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylate,
methyl 6-amino-5-chloro-2-(4-chlorophenyl)-4-pyrimidinecarboxylate,
ethyl 6-amino-5-chloro-2-(4-chlorophenyl)-4-pyrimidinecarboxylate,
6-amino-5-chloro-2-(4-chlorophenyl)-4-pyrimidinecarboxylic acid,

ethyl 6-amino-2-(4-bromophenyl)-5-chloro-4-pyrimidinecarboxylate,
methyl 6-amino-2-(4-bromophenyl)-5-chloro-4-pyrimidinecarboxylate, and
6-amino-2-(4-bromophenyl)-5-chloro-4-pyrimidinecarboxylic acid.

Also noteworthy as embodiments are herbicidal compositions of the present invention comprising the compounds of embodiments described above.

This invention also relates to a method for controlling undesired vegetation comprising applying to the locus of the vegetation herbicidally effective amounts of the compounds of the invention (e.g., as a composition described herein). Of note as embodiments relating to methods of use are those involving the compounds of embodiments described above.

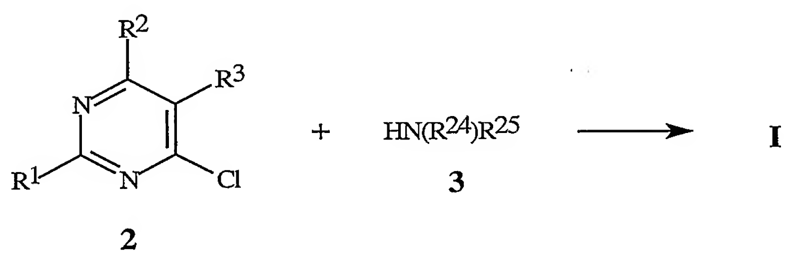
Of note is a compound of Formula **I**, including all geometric and stereoisomers, *N*-oxides or agriculturally suitable salts thereof, agricultural compositions containing them and their use as herbicides wherein R^2 is CO_2R^{12}, CH_2OR^{13}, CHO, $C(=NOR^{14})H$, $C(R^{15})(R^{16})CO_2R^{17}$ or $C(=O)N(R^{18})R^{19}$; each R^7 is independently halogen, C_1–C_4 alkyl, C_1–C_3 haloalkyl, C_1–C_3 alkoxy, C_1–C_3 haloalkoxy, C_1–C_3 alkylthio or C_1–C_3 haloalkylthio; R^{12} is H; or a radical selected from C_1–C_{14} alkyl, C_3–C_{12} cycloalkyl, C_4–C_{12} alkylcycloalkyl, C_4–C_{12} cycloalkylalkyl, C_2–C_{14} alkenyl and C_2–C_{14} alkynyl, each radical optionally substituted with 1–3 R^{27}; R^{13} is H, C_1–C_{10} alkyl optionally substituted with 1–3 R^{28} or benzyl; R^{14} is H, C_1–C_4 alkyl or C_1–C_4 haloalkyl; R^{15} and R^{16} are independently H, halogen, C_1–C_4 alkyl, C_1–C_4 haloalkyl, hydroxy or C_1–C_4 alkoxy; R^{17} is C_1–C_{10} alkyl optionally substituted with 1–3 R^{29} or benzyl; R^{18} and R^{19} are independently H or C_1–C_4 alkyl; each R^{27} is independently halogen, hydroxycarbonyl, C_2–C_4 alkoxycarbonyl, hydroxy, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, amino, C_1–C_4 alkylamino, C_2–C_4 dialkylamino, $-CH[O(CH_2)_n]$ or phenyl optionally substituted with 1–3 R^{44}; or two R^{27} are taken together with the carbon atom to which they are attached to form a carbonyl moiety; each R^{28} and R^{29} is independently halogen, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, amino, C_1–C_4 alkylamino or C_2–C_4 dialkylamino; each R^{30}, R^{31} and R^{32} is independently halogen, hydroxy, C_1–C_4 alkoxy, C_1–C_4 haloalkoxy, C_1–C_4 alkylthio, C_1–C_4 haloalkylthio, amino, C_1–C_4 alkylamino, C_2–C_4 dialkylamino or C_2–C_4 alkoxycarbonyl; each R^{38} is independently halogen, C_1–C_3 alkyl, C_1–C_3 alkoxy, C_1–C_3 haloalkoxy, C_1–C_3 alkylthio, C_1–C_3 haloalkylthio, amino, C_1–C_3 alkylamino, C_2–C_4 dialkylamino or C_2–C_4 alkoxycarbonyl; each R^{44} is independently halogen, C_1–C_4 alkyl, C_1–C_3 haloalkyl, hydroxy, C_1–C_4 alkoxy, C_1–C_3 haloalkoxy, C_1–C_4 alkylthio, C_1–C_3 haloalkylthio, amino, C_1–C_3 alkylamino, C_2–C_4 dialkylamino or nitro; m is an integer from 2 to 5; and n is an integer from 1 to 4. Also of note is a compound of Formula **I**, including all geometric and stereoisomers, *N*-oxides or agriculturally suitable salts thereof, agricultural compositions containing them and their use as herbicides wherein each R^5 and R^6 is independently halogen, C_1–C_2 alkyl or C_1–C_2 haloalkyl; R^{15} is H, halogen, C_1–C_4 alkyl, C_1–C_4 haloalkyl, hydroxy, C_1–C_4 alkoxy or C_2–

C_4 alkylcarbonyloxy; R^{16} is H, halogen, C_1–C_4 alkyl or C_1–C_4 haloalkyl; R^{24} is H, C_1–C_4 alkyl optionally substituted with 1–2 R^{30}, C_2–C_4 alkenyl optionally substituted with 1–2 R^{31}, or C_2–C_4 alkynyl optionally substituted with 1–2 R^{32}; or R^{24} is $C(=O)R^{33}$, nitro, OR^{34}, $S(O)_2R^{35}$ or $N(R^{36})R^{37}$; each R^{33} is independently H, C_1–C_4 alkyl, C_1–C_3 haloalkyl, C_1–C_4 alkoxy, phenoxy or benzyloxy; R^{34} is H, C_1–C_4 alkyl, C_1–C_3 haloalkyl; and R^{36} is H or C_1–C_4 alkyl.

The compounds of Formula **I** can be prepared by one or more of the following methods and variations as described in Schemes 1 through 7 and accompanying text. The definitions of R, R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^{12}, R^{13}, R^{14}, R^{15}, R^{16}, R^{17}, R^{18}, R^{19}, R^{20}, R^{21}, R^{22}, R^{23}, R^{24}, R^{25}, R^{27}, R^{28}, R^{29}, R^{30}, R^{31}, R^{32}, R^{33}, R^{34}, R^{35}, R^{36}, R^{37}, R^{38}, R^{39}, R^{40}, R^{41}, R^{42}, R^{43}, R^{44}, R^{45}, R^{46}, R^{47}, R^{48}, R^{49}, R^{50}, R^{51}, R^{52}, R^{53}, R^{54}, R^{55}, R^{56}, R^{57}, R^{58}, R^{59}, R^{60}, R^{61}, Y, j, k and n in the compounds of Formulae **I** through **12** below are as defined above in the Summary of the Invention and description of embodiments unless otherwise indicated.

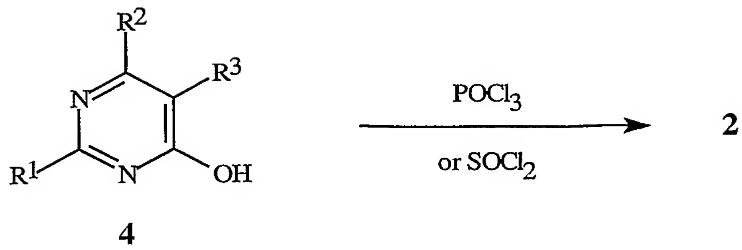
Compounds of Formula **I** can be prepared from chlorides of Formula **2** by reaction with amines of Formula **3**, optionally in the presence of a base such as triethylamine or potassium carbonate as outlined in Scheme 1. The reaction can be run in a variety of solvents including tetrahydrofuran, *p*-dioxane, ethanol and methanol with optimum temperatures ranging from room temperature to 200 °C. The method of Scheme 1 is illustrated in Step C of Example 1, Steps D1 and D2 of Example 2, and Step B of Example 4.

<u>Scheme 1</u>



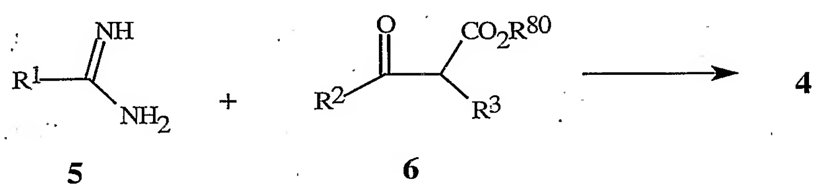
Compounds of Formula **2** can be prepared from hydroxy compounds of Formula **4** (which may exist in the keto form) by reaction with a chlorination reagent such as phosphorous oxychloride or thionyl chloride, optionally in the presence of a base such as *N*,*N*-dimethylaniline as shown in Scheme 2. The reaction can be run neat or in the presence of a solvent such as *N*,*N*-dimethylformamide at temperatures ranging from room temperature to 120 °C. The method of Scheme 2 is illustrated in Step C of Example 1, Steps C1 and C2 of Example 2, and Step B of Example 4.

Scheme 2



Compounds of Formula **4** can be prepared by the condensation of amidines of Formula **5** with keto esters of Formula **6** in solvents such as methanol or ethanol at temperatures ranging from room temperature to the reflux temperature of the solvent as shown in Scheme 3. Optionally a base such as a metal alkoxide or 1,1,3,3-tetramethylguanidine may be employed. The method of Scheme 3 is illustrated in Step A of Examples 1 and 4, and Steps A1 and A2 of Example 2.

Scheme 3



wherein R^{80} is a carbon moiety such as alkyl, preferably C_1–C_2 alkyl.

Compounds of Formula **4** wherein R^3 is a halogen can be prepared from compounds of Formula **4** wherein R^3 is hydrogen by reaction with a halogen such as bromine or a halogenating reagent such as an *N*-halosuccinimide or a sulfuryl halide in a variety of solvents including acetic acid, *N*,*N*-dimethylformamide, dichloromethane and carbon tetrachloride at temperatures ranging from 0–100 °C as shown in Scheme 4. The method of Scheme 4 is illustrated in Step B of Example 1, and Steps B1 and B2 of Example 2.

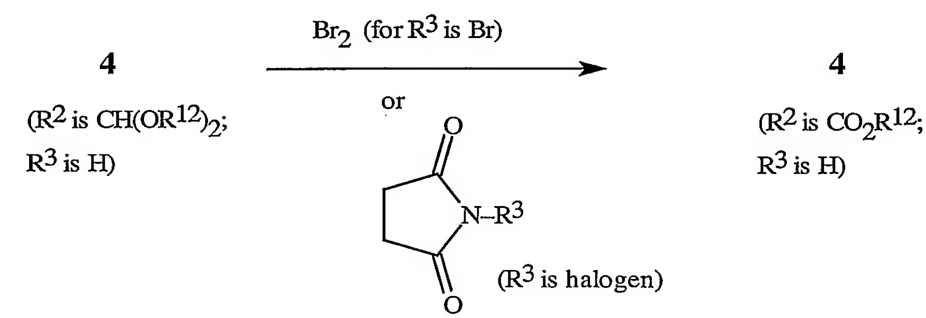
Scheme 4

$$\underset{(R^3 \text{ is H})}{\mathbf{4}} \xrightarrow{\text{halogenating reagent}} \underset{(R^3 \text{ is halogen})}{\mathbf{4}}$$

Also, compounds of Formula **I** wherein R^3 is a halogen can be prepared from compounds of Formula **I** wherein R^3 is hydrogen by reaction with a halogenating reagent analogous to the method of Scheme 4. This alternative method is illustrated in Step C of Example 4.

A particularly useful preparation of compounds of Formula **4** wherein R^3 is a halogen and R^2 is CO_2R^{12} is the reaction of compounds of Formula **4** where R^3 is hydrogen and R^2 is $CH(OR^{12})_2$ with a halogenating reagent and oxidizing reagent such as an *N*-halosuccinimide or bromine (when R^3 is bromine) in a solvent such as dichloromethane, trichloromethane or tetrachloromethane at temperatures ranging from room temperature to the reflux temperature of the solvent as shown in Scheme 5.

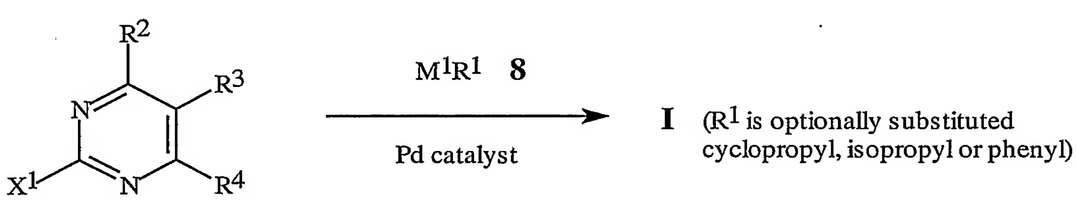
Scheme 5



Compounds of Formula **5** and **6** are either commercially available or can be prepared by known methods. (For example see: P. J. Dunn in *Comprehensive Organic Functional Group Transformations*, A. R. Katritzky, O. Meth-Cohn, C.W. Rees Eds, Pergamon Press; Oxford, 1995; vol. 5, pp.741–782; T.L. Gillchrist in *Comprehensive Organic Functional Group Transformations*, A. R. Katritzky, O. Meth-Cohn, C.W. Rees Eds., Pergamon Press; Oxford, 1995; vol. 6, pp. 601–637 and B. R. Davis, P. J. Garratt in *Comprehensive Organic Synthesis*, B. M. Trost Ed., Pergamom Press; Oxford, 1991; vol. 2, pp. 795–803.)

Alternatively compounds of Formula **I** can be prepared from corresponding compounds of Formula **7** wherein X^1 is a leaving group, such as a halogen or alkylsulfonyl group (e.g., methanesulfonyl, trifluoromethanesulfonyl, benzenesulfonyl), as shown in Scheme 6.

Scheme 6



7

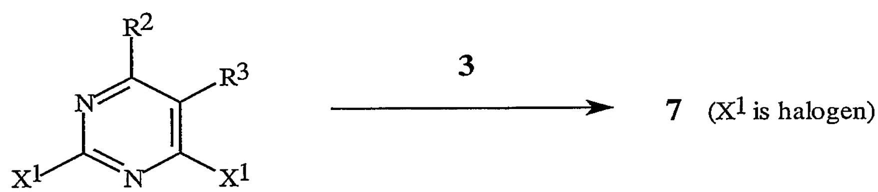
wherein M^1 is $B(OH)_2$, $Sn(n\text{-}Bu)_3$, MgX^1 or ZnX^1; R^1 is optionally substituted cyclopropyl, optionally substituted isopropyl or optionally substituted phenyl; and X^1 is a leaving group.

This method involves palladium-catalyzed reaction of a compound of Formula **7** with a compound of Formula **8** in the form of a boronic acid (e.g., M^1 is $B(OH)_2$), an organotin

reagent (e.g., M^1 is $Sn(n\text{-}Bu)_3$), a Grignard reagent (e.g., M^1 is MgX^1) or an organozinc reagent (e.g., M^1 is ZnX^1). (For example see: N. Ali, A. McKillop, M. Mitchell, R. Rebelo, A. Ricardo, P. Wallbank, *Tetrahedron*, **1992**, *48*, 8117–8126; J. Solberg, K. Undheim, *Acta Chem. Scand.*, **1989**, *43*, 62–68, V. Bonnet, F. Mongin, F. Trécourt, G. Quéguiner and P. Knochel, *Tetrahedron*, **2002**, *58*, 4429–4438.)

Compounds of Formula **7** wherein X^1 is a halogen can be prepared from dihalo compounds of Formula **12** with an amine of Formula **3** optionally catalyzed by a base such as triethylamine or potassium carbonate in a variety of solvents including tetrahydrofuran and dichloromethane at temperatures ranging from 0 °C to the reflux temperature of the solvent as shown in Scheme 7.

Scheme 7

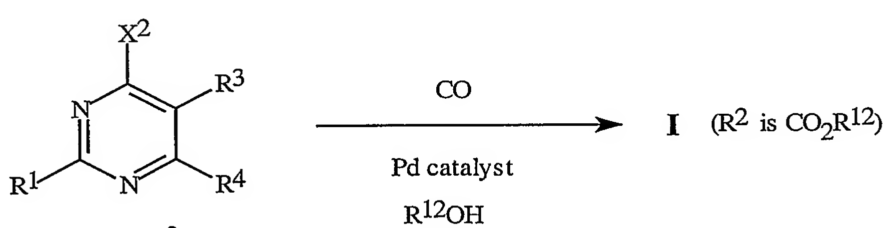


12 (X^1 is halogen)

Compounds of Formula **12** can be prepared by known methods. (For example, see H. Gershon, *J. Org. Chem.*, **1962**, *27*, 3507–3510.)

As shown in Scheme 8, compounds of Formula **I** wherein R^2 is CO_2R^{12} can also be prepared from compounds of Formula **13** by means of a carbonylation reaction. Typical conditions are 1–10 atmospheres of carbon monoxide in the presence of a palladium catalyst in a mixture of an alcohol and another solvent such as *N,N*-dimethylformamide, *N*-methylpyrrolidinone or tetrahydrofuran at temperatures ranging from room temperature to 150 °C.

Scheme 8



13 (X^2 is Cl or Br)

As shown in Scheme 9, compounds of Formula **13** can be prepared from compounds of Formula **14** by reaction with amines of Formula **3** in a reaction analogous to the method of Scheme 1.

Scheme 9

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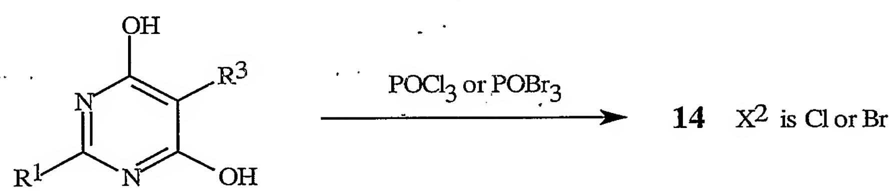
As shown in Scheme 10, compounds of Formula **14** can be prepared from diols of Formula **15** by reaction with a halogenating agent such as phosphorous oxychloride or phosphorous oxybromide in a reaction analogous to the method of Scheme 2. (See H. Gershon, R. Braun, A. Scala and R. Rodin, *J. Med. Chem* **1964**, *7*, 808–811 and M. H. Norman, N. Chen, Z. Chen, C. Fotsch, N. Han, R. Hurt, T. Jenkins J. Kincaid, L. Liu, Y. Lu, O. Moreno, V. J. Santora, J.D. Sonnenberg and W. Karbon, *J. Med. Chem,* **2000**, *43*, 4288–4312 for examples of this method and for examples of preparation of compounds of Formula **15**.)

Scheme 10



15

Compounds of Formula **I** wherein R^2 comprises an ester function (e.g., CO_2R^{12} wherein R^{12} is other than H) can be prepared from corresponding carboxylic acid compounds of Formula **I** (e.g., wherein R^{12} is H) by a wide variety of esterification methods known in the art. One method is illustrated in Example 3. Conversely, carboxylic acid compounds of Formula **I** can be prepared from the corresponding ester compounds by a wide variety of hydrolysis methods known in the art, such as saponfication.

It is recognized that some reagents and reaction conditions described above for preparing compounds of Formula **I** may not be compatible with certain functionalities present in the intermediates. In these instances, the incorporation of protection/deprotection sequences or functional group interconversions into the synthesis will aid in obtaining the desired products. The use and choice of the protecting groups will be apparent to one skilled in chemical synthesis (see, for example, T. W. Greene, P. G. M. Wuts, *Protective Groups in Organic Synthesis*, 2nd ed.; Wiley: New York, 1991). One skilled in the art will recognize that, in some cases, after the introduction of a given reagent as it is depicted in any individual scheme, it may be necessary to perform additional routine synthetic steps not described in detail to complete the synthesis of compounds of Formula **I**. One skilled in the

art will also recognize that it may be necessary to perform a combination of the steps illustrated in the above schemes in an order other than that implied by the particular sequence presented to prepare the compounds of Formula **I**.

One skilled in the art will also recognize that compounds of Formula **I** and the intermediates described herein can be subjected to various electrophilic, nucleophilic, radical, organometallic, oxidation, and reduction reactions to add substituents or modify existing substituents.

Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be construed as merely illustrative, and not limiting of the disclosure in any way whatsoever. Steps in the following Examples illustrate a procedure for each step in an overall synthetic transformation, and the starting material for each step may not have necessarily been prepared by a particular preparative run whose procedure is described in other Examples or Steps. Percentages are by weight except for chromatographic solvent mixtures or where otherwise indicated. Parts and percentages for chromatographic solvent mixtures are by volume unless otherwise indicated. ^{1}H NMR spectra are reported in ppm downfield from tetramethylsilane; "s" means singlet, "d" means doublet, "t" means triplet, "q" means quartet, "m" means multiplet, "dd" means doublet of doublets, "ddd" means doublet of doublets of doublets, "dt" means doublet of triplets, "dq" means doublet of quartets, "br s" means broad singlet, "br d" means broad doublet.

EXAMPLE 1

Preparation of ethyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate (Compound 1) and
methyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate (Compound 2)

Step A: Preparation of 2-cyclopropyl-6-(diethoxymethyl)-4(1*H*)-pyrimidinone

To a mixture of ethyl 4,4-diethoxy-3-oxobutanoate (prepared according to the method of E. Graf, R. Troschutz, *Synthesis*, **1999**, *7*, 1216; 10.0 g, 46 mmol) and cyclopropanecarboximidamide monohydrochloride (Lancaster Synthesis, 5.0 g, 41 mmol) in methanol (100 mL) was added a methanol solution of sodium methoxide (5.4 M, 8.4 mL, 46 mmol). The reaction mixture was stirred overnight. The solvent was removed with a rotary evaporator. Dichloromethane was added and the mixture was filtered. The solvent from the filtrate was removed with a rotary evaporator. The residue was purified by medium pressure liquid chromatography (MPLC) (35→100% ethyl acetate in hexanes as eluant) to afford the title compound as a white solid (4.67 g).

^{1}H NMR ($CDCl_3$) δ 6.55 (s, 1H), 5.10 (s, 1H), 3.61 (m, 4H), 1.91 (m, 1H), 1.23 (m, 8H), 1.09 (m, 2H).

Additionally 3.24 g of an undehydrated product was obtained. This material could be converted to the title compound by refluxing it in methanol with a catalytic amount of pyridinium *p*-toluenesulfonate.

Step B: Preparation of ethyl 5-bromo-2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylate

To a solution of 2-cyclopropyl-6-(diethoxymethyl)-4(1*H*)-pyrimidinone (i.e. the title product of Step A) (2.9 g, 12.1 mmol) in dichloromethane (75 mL) was added *N*-bromosuccinimide (4.76 g, 26.8 mmol). The reaction mixture was stirred overnight. The solvent was removed with a rotary evaporator. The residue was purified by MPLC (1→4% methanol in dichloromethane as eluant) to afford the title compound as a white solid (2.68 g).

^{1}H NMR ($CDCl_3$) δ 4.43 (q, 2H), 1.90 (m, 1H), 1.41 (t, 3H), 1.30 (m, 2H), 1.20 (m, 2H).

Step C: Preparation of ethyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate and methyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate

To a solution of ethyl 5-bromo-2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylate (i.e. the product of Step B) (1.07 g, 3.7 mmol) in *N*,*N*-dimethylformamide (15 mL) was added thionyl chloride (0.54 mL, 7.5 mmol). The reaction mixture was stirred for 2 h. The solvent was removed with a rotary evaporator. The residue was dissolved in dichloromethane, washed with saturated aqueous sodium bicarbonate and dried (Na_2SO_4). The solvent was removed with a rotary evaporator. The residue was dissolved in tetrahydrofuran (2 mL), and a methanolic solution of ammonia (7 N, 2 mL) was added. The reaction mixture was placed in a sealed vial and heated in a microwave reactor at 125 °C for 2h. The reaction mixture was allowed to stand over the weekend. Dichloromethane was added and the reaction mixture was filtered. The solvent was removed with a rotary evaporator. The residue was purified by MPLC (10→30% ethyl acetate in hexanes as eluant) to afford the title product, a compound of the present invention, as a white solid (0.52 g).

^{1}H NMR ($CDCl_3$) δ 5.40 (br s, 2H), 4.44 (q, 2H), 2.05 (m, 1H), 1.01 (t, 3H), 1.05 (m, 2H), 0.99 (m, 2H).

Also isolated from the MPLC purification was the corresponding methyl ester, i.e. methyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate, a further compound of the present invention, as a white solid (0.06 g).

^{1}H NMR ($CDCl_3$) δ 5.40 (br s, 2H), 3.97 (s, 3H) 2.05 (m, 1H), 1.05 (m, 2H), 0.99 (m, 2H).

EXAMPLE 2

Preparation of 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylic acid (Compound 135)

Step A1: Preparation of 2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylic acid

To a mixture of diethyl oxalacetate sodium salt (150 g, 714 mmol) in methanol (300 mL) and water (150 mL) warmed to 30 °C was added 50% aqueous sodium hydroxide (56 g, 700 mmol) in water (60 mL) over 30 minutes, over which time the temperature remained at 25–30 °C and the pH at 11–12. Then the stirred mixture was heated for an additional 30 min at 35 °C. To this mixture was added cyclopropanecarboximidamide monohydrochloride (64 g, 530 mol) in portions over 15 minutes. The orange solution was heated to 50 °C over 30 minutes and held at that temperature for 3 h. The reaction mixture was cooled to 35 °C, and concentrated hydrochloric acid (ca. 70 g, 0.7 mol) was added gradually (resulting in foaming) over 30 minutes at 30–40 °C until the pH was about 1.5–2.5. The mixture was concentrated with a rotary evaporator at 35–40 °C to remove alcohols, stirred for 3–4 h at 25 °C to complete crystallization of the product. After the mixture was cooled to 0 °C the solid was collected by filtration. The solid was washed with water (2 x 60 mL), suction-dried, and then dried in a vacuum-oven at 60 °C to afford the title compound as a beige solid (ca. 60 g).

^{1}H NMR (DMSO-d_6) δ 6.58 (s, 1H), 1.95 (m, 1H), 1.0 (m, 4H).

Step A2: Another preparation of 2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidine-carboxylic acid

To a mixture of diethyl oxalacetate sodium salt (210 g, 950 mmol) in methanol (500 mL) and water (400 mL) was added 50% aqueous sodium hydroxide (80 g, 1.0 mol) in water (60 mL) over 30 minutes, over which time the temperature remained at 25–30 °C and the pH at 11–12. Then the stirred mixture was heated for an additional 30 min at 30 °C. To this mixture was added cyclopropanecarboximidamide monohydrochloride (110 g, 910 mol). The orange solution was heated to 50 °C over 30 minutes and held at that temperature for 5 h. The reaction mixture was cooled to 30 °C and concentrated to half volume at reduced pressure at 35–40 °C and concentrated hydrochloric acid (140 g, 1.4 mol) was added gradually (resulting in foaming) over 30 minutes at 25–30 °C until the pH was about 1–2. The mixture was stirred at 5 °C for 1 h to complete crystallization of the product. After the mixture was cooled to 0 °C the solid was collected by filtration. The solid was washed with water (3 x 60 mL), suction-dried, and then dried in a vacuum-oven at 70 °C to afford the title compound as a beige solid (100 g); m.p. 235–236 °C (dec.).

^{1}H NMR (DMSO-d_6) δ 6.58 (s, 1H), 1.95 (m, 1H), 1.0 (m, 4H).

Step B1: Preparation of 5-chloro-2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylic acid

To a mixture of 2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylic acid (i.e. the product of Step A1 or A2) (9.2 g, 52 mmol) in water (30 mL) and concentrated hydrochloric acid (22 g, 220 mmol) at 15 °C was added dropwise aqueous sodium hypochlorite solution (11%, 40 g, 59 mmol) over 15 minutes so that with cooling the reaction mixture was maintained at 15–20 °C. The mixture was then held at 20–25 °C for 1 h. Solid sodium bisulfite (ca. 2 g) was added, and then aqueous sodium hydroxide solution (50%, 8 g, 0.10 mol) was added dropwise so that with cooling the reaction mixture was maintained at about 25 °C. The mixture was cooled to 10 °C, and the suspended product was isolated by filtration and washed with a minimum amount of cold water. The product was then dried to constant weight in vacuum-oven at 50 °C to afford the title compound (7.5 g).

^{1}H NMR (DMSO-d_6) δ 13.4 (br s, 1H), 1.95 (m, 1H), 1.0 (m, 4H).

Step B2: Another preparation of 5-chloro-2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylic acid

To a mixture of 2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylic acid (i.e. the product of Step A1 or A2) (184 g, 1.02 mol) in water (45 mL) and concentrated hydrochloric acid (292 g, 3 mol) at 8–12 °C was added dropwise aqueous sodium hypochlorite solution (8.4%, 1.02 kg, 1.15 mol) over 2 h so that with cooling the reaction mixture was maintained at 8–10 °C. The mixture was then held at 10–12 °C for 1 h and the conversion was monitored by HPLC. When less than 5% of the starting material remained solid sodium bisulfite was added until a negative KI starch paper test was obtained. The mixture was cooled to 5 °C, and the suspended product was isolated by filtration and washed with a minimum amount of cold water. The product was then dried to constant weight in vacuum-oven at 50 °C to afford the title compound (194 g); m.p. 189–190 °C.

^{1}H NMR (DMSO-d_6) δ 13.4 (br s, 1H), 1.95 (m, 1H), 1.0 (m, 4H).

Step C1: Preparation of 5,6-dichloro-2-cyclopropyl-4-pyrimidinecarboxylic acid

Phosphorus oxychloride (14 mL, 23 g, 0.15 mol) and 5-chloro-2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylic acid (i.e. the product of Step B1 or B2) (75 g, 300 mmol) were combined and heated at 85 °C for 3 h. The reaction mixture was cooled to 30 °C and added over 30 minutes to a mixture of acetonitrile (50 mL) and ice water (80 mL), with the temperature maintained at 5–10 °C and the pH maintained in the range 1–3 by co-feeding aqueous ammonia (28%). The pH was adjusted to about 2, the mixture was concentrated at 25 °C with a rotary evaporator to remove acetonitrile, and the precipitated product was isolated by filtration and washed with water (2 x 25 mL). The solid was dried in a vacuum oven to afford the title compound (ca. 7.0 g).

^{1}H NMR (DMSO-d_6) δ 2.23 (m, 1H), 1.2 (m, 2H), 1.0 (m, 2H).

Step C2: Another preparation of 5,6-dichloro-2-cyclopropyl-4-pyrimidinecarboxylic acid

Phosphorus oxychloride (200 mL, 328 g, 2.14 mol) and 5-chloro-2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylic acid (i.e. the product of Step B1 or B2) (96.8 g, 451 mmol) were combined and heated at 90 °C for 5 h. The reaction mixture was cooled to 50–60 °C and concentrated at reduced pressure to half volume. After cooling to 30 °C the reaction mixture was added over 60 minutes to a mixture of *t*-butanol (200 mL) and water (300 mL), with the temperature maintained at 8–10 °C. The mixture was seeded, water (300 mL) was added gradually at 10–15 °C and the mixture was stirred for 1 h. After cooling to 5 °C the precipitated product was isolated by filtration and washed with water (3 x 50 mL). The solid was dried in a vacuum oven to afford the title compound (93 g).

^{1}H NMR (DMSO-d_6) δ 2.23 (m, 1H), 1.2 (m, 2H), 1.0 (m, 2H).

Step D1: Preparation of 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylic acid

A mixture of 5,6-dichloro-2-cyclopropyl-4-pyrimidinecarboxylic acid (i.e. the product of Step C1 or C2) (5.1 g, 22 mmol), water (30 mL) and aqueous ammonia (28%, 8 g, 130 mmol) was heated at 80 °C for 3 h. The solution was concentrated at 50 °C and 70 torr (9.3 kPa) pressure to about half volume to remove most of the excess ammonia. The resulting slurry was stirred at 20 °C, acidified to pH 2 with aqueous hydrochloric acid, cooled to 5 °C and filtered. The isolated solid was dried in a vacuum oven to afford the title product (4.2 g), a compound of the present invention.

^{1}H NMR (DMSO-d_6) δ 13.4 (br s, 1H), 1.95 (m, 1H), 1.0 (m, 4H).

Step D2: Another preparation of 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylic acid

A mixture of 5,6-dichloro-2-cyclopropyl-4-pyrimidinecarboxylic acid (i.e. the product of Step C1 or C2) (280 g, 1.2 mol), water (1.26 L) and aqueous ammonia (28%, 350 g, 5.76 mol) was heated at 80 °C for 5 h. The solution was concentrated at 50 °C and 70 torr (9.3 kPa) pressure to about half volume to remove most of the excess ammonia. The resulting slurry was stirred at 20 °C, acidified to pH 1–2 with aqueous hydrochloric acid, cooled to 5 °C and filtered. The isolated solid was dried in a vacuum oven to afford the title product (270 g), a compound of the present invention.

^{1}H NMR (DMSO-d_6) δ 13.4 (br s, 1H), 1.95 (m, 1H), 1.0 (m, 4H).

EXAMPLE 3

Preparation of methyl 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylate (Compound 9)

To a solution of 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylic acid (i.e. the product of Step D1 or D2 of Example 2) (2.0 g, 8.5 mmol) in methanol (20 mL) was added dropwise thionyl chloride (4 mL, 70 mmol). The mixture was heated at reflux for 24 h. Concentrated sulfuric acid (5 drops) was added, and the reaction mixture was heated at

reflux for 16 h. After the mixture was cooled, water (30 mL) was added, and aqueous ammonia (28%, 10 mL) was added dropwise. The mixture was cooled to 5 °C, and the solid was isolated by filtration, washed with water and dried in a vacuum oven at 40 °C to afford the title product (2.3 g), a compound of the present invention.

^{1}H NMR ($CDCl_3$) δ 5.41 (br s, 2H), 3.98 (s, 3H), 2.06 (m, 1H), 1.04 (m, 2H), 1.00 (m, 2H).

Another preparation of methyl 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylate

To a solution of 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylic acid (i.e. the product of Step D1 or D2 of Example 2) (8.5 g, 40 mmol) in methanol (120 mL) was added dropwise with cooling thionyl chloride (15 mL, 200 mmol). The mixture was heated at 60 °C for 24 h. The mixture was concentrated to 25% of the original volume and diluted with water (100 mL). Phenolphthalein pH indicator was added, and 10% aqueous sodium hydroxide was added dropwise with cooling at 10–20 °C to bring the pH to 8–10. The solid was isolated by filtration, washed with water and dried in a vacuum oven at 50–60 °C to afford the title product (7.3 g), a compound of the present invention.

^{1}H NMR ($CDCl_3$) δ 5.41 (br s, 2H), 3.98 (s, 3H), 2.06 (m, 1H), 1.04 (m, 2H), 1.00 (m, 2H).

EXAMPLE 4

Preparation of 6-amino-5-chloro-2-(4-chlorophenyl)-4-pyrimidinecarboxylic acid (Compound 65)

Step A: Preparation of 2-(4-chlorophenyl)-1,6-dihydro-6-oxo-4-pyrimidinecarboxylic acid

To a mixture of diethyl oxalacetate sodium salt (123.2 g, 586 mmol) in water (750 mL) was slowly added aqueous sodium hydroxide (50%, 47 g, 586 mmol). After 1 h the solids had dissolved. 4-Chlorobenzenecarboximidamide monohydrochloride (111.95 g, 586 mmol) was then added, and the mixture was heated at 70 °C overnight. After cooling to room temperature concentrated hydrochloric acid was slowly added (causing foaming) until the pH was lowered to 1.5. The solid was isolated by filtration and washed with water and methanol. The solid was then triturated twice with hot methanol, washed repeatedly with 1 N hydrochloric acid, then once with methanol and dried to afford the title compound (66.07 g).

^{1}H NMR (DMSO-d_6) δ 8.23 (d, 2H), 7.65 (d, 2H), 6.90 (s, 1H).

Step B: Preparation of 6-amino-2-(4-chlorophenyl)-4-pyrimidinecarboxylic acid

To phosphorus oxychloride (180 mL) was added 2-(4-chlorophenyl)-1,6-dihydro-6-oxo-4-pyrimidinecarboxylic acid (i.e. the product of Step A) (81.81 g, 326 mmol). The mixture was heated to 90 °C for 2.5 h. After cooling to room temperature the reaction mixture was slowly added to 1:2 acetonitrile:water (1.5 L) while keeping the temperature between 35 and 45 °C. After the reaction mixture was stirred at room temperature for

30 minutes the resulting solid was isolated by filtration and washed with water. The solid was then combined with aqueous ammonia (5%, 2.1 L) and heated to 80 °C for 18 h. After 2 days at room temperature the solid was isolated by filtration and washed with water. A second crop was obtained by cooling the filtrate and refiltering. The combined solids were dried to afford the title compound (58.8 g).

^{1}H NMR (DMSO-d_6) δ 8.33 (d, 2H), 7.51 (d, 2H), 6.89 (s, 2H), 6.81 (s, 1H).

Step C: Preparation of 6-amino-5-chloro-2-(4-chlorophenyl)-4-pyrimidinecarboxylic acid

To a solution of 6-amino-2-(4-chlorophenyl)-4-pyrimidinecarboxylic acid (i.e. the product of Step B) (75 g, 300 mmol) in *N,N*-dimethylformamide (300 mL) at 50 °C was added portionwise *N*-chlorosuccinimide (44.1 g, 330 mmol). The temperature of the reaction mixture increased exothermically to 65 °C. Then the reaction mixture was heated at 55 °C for 3 h. Additional *N*-chlorosuccinimide (14 g, 90 mmol) was added portionwise, and the reaction mixture was maintained at 55 °C for 30 minutes. After the reaction mixture was cooled water was added. The resulting solid was isolated by filtration, washed with water, dissolved in ethyl acetate, washed with water and dried. The solvent was removed using a rotary evaporator to afford the title product, a compound of the present invention, as a tan solid (73.68 g).

^{1}H NMR (DMSO-d_6) δ 8.28 (d, 2H), 7.70 (br s, 2H), 7.58 (d, 2H).

EXAMPLE 5

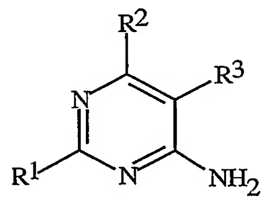
Preparation of ethyl 6-amino-5-chloro-2-(4-chlorophenyl)-4-pyrimidinecarboxylate (Compound 64)

To a solution of 6-amino-5-chloro-2-(4-chlorophenyl)-4-pyrimidinecarboxylic acid (i.e. the product of Example 4, Step C) (20.0 g, 70.4 mmol) in ethanol (70 mL) was added thionyl chloride (5.14 mL, 70.4 mmol) while maintaining the temperature below 15 °C using an ice bath. The reaction mixture was then heated at reflux overnight. Water was added. Then with external cooling aqueous sodium hydroxide (50%) was added to adjust the pH to 7. The resulting solid was isolated by filtration and dried to afford the title product, a compound of the present invention, as a light beige solid (20.1 g).

^{1}H NMR ($CDCl_3$) δ 8.31 (d, 2H), 7.42 (d, 2H), 5.50 (br s, 2H), 4.50 (q, 2H), 1.47 (t, 3H).

By the procedures described herein together with methods known in the art, the following compounds of Tables 1 to 4 can be prepared. The following abbreviations are used in the Tables which follow: *t* means tertiary, *i* means iso, Me means methyl, Et means ethyl, Pr means propyl, *i*-Pr means isopropyl, Bu means butyl, *t*-Bu means *tert*-butyl, CN means cyano, and $S(O)_2Me$ means methylsulfonyl. "⊖" means negative formal charge, and "⊕" means positive formal charge.

TABLE 1



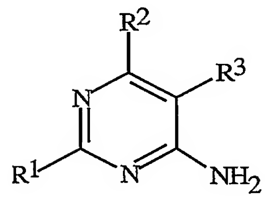
R^1 is cyclopropyl; R^3 is Cl.	R^1 is cyclopropyl; R^3 is F.	R^1 is cyclopropyl; R^3 is Br.	R^1 is cyclopropyl; R^3 is I.
R^2	R^2	R^2	R^2
CO_2H	CO_2H	CO_2H	CO_2H
CO_2Me	CO_2Me	CO_2Me	CO_2Me
CO_2Et	CO_2Et	CO_2Et	CO_2Et
CO_2Pr	CO_2Pr	CO_2Pr	CO_2Pr
CO_2*i*Pr	CO_2*i*Pr	CO_2*i*Pr	CO_2*i*Pr
CO_2*t*-Bu	CO_2*t*-Bu	CO_2*t*-Bu	CO_2*t*-Bu
CO_2cyclohexyl	CO_2cyclohexyl	CO_2cyclohexyl	CO_2cyclohexyl
CO_2hexyl	CO_2hexyl	CO_2hexyl	CO_2hexyl
CO_2CH_2cyclohexyl	CO_2CH_2cyclohexyl	CO_2CH_2cyclohexyl	CO_2CH_2cyclohexyl
CO_2CH_2Ph	CO_2CH_2Ph	CO_2CH_2Ph	CO_2CH_2Ph
$CO_2CH(Me)Ph$	$CO_2CH(Me)Ph$	$CO_2CH(Me)Ph$	$CO_2CH(Me)Ph$
CO_2CH_2(4-Cl-Ph)	CO_2CH_2(4-Cl-Ph)	CO_2CH_2(4-Cl-Ph)	CO_2CH_2(4-Cl-Ph)
CO_2CH_2(3-F-Ph)	CO_2CH_2(3-F-Ph)	CO_2CH_2(3-F-Ph)	CO_2CH_2(3-F-Ph)
$CO_2CH_2CH_2NMe_2$	$CO_2CH_2CH_2NMe_2$	$CO_2CH_2CH_2NMe_2$	$CO_2CH_2CH_2NMe_2$
$CO_2CH_2CH_2OMe$	$CO_2CH_2CH_2OMe$	$CO_2CH_2CH_2OMe$	$CO_2CH_2CH_2OMe$
$CO_2CH_2CH_2OH$	$CO_2CH_2CH_2OH$	$CO_2CH_2CH_2OH$	$CO_2CH_2CH_2OH$
CO_2CH_2(3-oxetanyl)	CO_2CH_2(3-oxetanyl)	CO_2CH_2(3-oxetanyl)	CO_2CH_2(3-oxetanyl)
CH_2OH	CH_2OH	CH_2OH	CH_2OH
CH_2OMe	CH_2OMe	CH_2OMe	CH_2OMe
CH_2CO_2Me	CH_2CO_2Me	CH_2CO_2Me	CH_2CO_2Me
$CH(OH)CO_2Me$	$CH(OH)CO_2Me$	$CH(OH)CO_2Me$	$CH(OH)CO_2Me$
$CH(OC(=O)Me)CO_2Me$	$CH(OC(=O)Me)CO_2Me$	$CH(OC(=O)Me)CO_2Me$	$CH(OC(=O)Me)CO_2Me$
CHO	CHO	CHO	CHO
C(=NOH)H	C(=NOH)H	C(=NOH)H	C(=NOH)H
C(=NOMe)H	C(=NOMe)H	C(=NOMe)H	C(=NOMe)H
$C(=O)NH_2$	$C(=O)NH_2$	$C(=O)NH_2$	$C(=O)NH_2$
C(=O)NHMe	C(=O)NHMe	C(=O)NHMe	C(=O)NHMe
$C(=O)NMe_2$	$C(=O)NMe_2$	$C(=O)NMe_2$	$C(=O)NMe_2$
CO_2Ph	CO_2Ph	CO_2Ph	CO_2Ph

$C(O)O^{\ominus}$ $H_3N^{\oplus}$Me	$C(O)O^{\ominus}$ $H_3N^{\oplus}$Me	$C(O)O^{\ominus}$ $H_3N^{\oplus}$Me	$C(O)O^{\ominus}$ $H_3N^{\oplus}$Me
$C(O)O^{\ominus}$ $H_3N^{\oplus}$*i*-Pr	$C(O)O^{\ominus}$ $H_3N^{\oplus}$*i*-Pr	$C(O)O^{\ominus}$ $H_3N^{\oplus}$*i*-Pr	$C(O)O^{\ominus}$ $H_3N^{\oplus}$*i*-Pr
$C(O)O^{\ominus}$ $H_3N^{\oplus}$Pr	$C(O)O^{\ominus}$ $H_3N^{\oplus}$Pr	$C(O)O^{\ominus}$ $H_3N^{\oplus}$Pr	$C(O)O^{\ominus}$ $H_3N^{\oplus}$Pr
$C(O)O^{\ominus}$ $H_3N^{\oplus}$butyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$butyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$butyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$butyl
$C(O)O^{\ominus}$ $H_3N^{\oplus}$hexyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$hexyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$hexyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$hexyl
$C(O)O^{\ominus}$ $H_3N^{\oplus}$octyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$octyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$octyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$octyl
$C(O)O^{\ominus}$ $H_3N^{\oplus}$hexadecyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$hexadecyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$hexadecyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$hexadecyl
$C(O)O^{\ominus}$ $H_3N^{\oplus}$octadecyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$octadecyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$octadecyl	$C(O)O^{\ominus}$ $H_3N^{\oplus}$octadecyl
$C(O)O^{\ominus}H_3N^{\oplus}$cyclohexyl	$C(O)O^{\ominus}H_3N^{\oplus}$cyclohexyl	$C(O)O^{\ominus}H_3N^{\oplus}$cyclohexyl	$C(O)O^{\ominus}H_3N^{\oplus}$cyclohexyl
$C(O)O^{\ominus}$ $H_2N^{\oplus}(Et)_2$	$C(O)O^{\ominus}$ $H_2N^{\oplus}(Et)_2$	$C(O)O^{\ominus}$ $H_2N^{\oplus}(Et)_2$	$C(O)O^{\ominus}$ $H_2N^{\oplus}(Et)_2$
$C(O)O^{\ominus}$ $H_2N^{\oplus}\{(CH_2)_2O(CH_2)_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{(CH_2)_2O(CH_2)_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{(CH_2)_2O(CH_2)_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{(CH_2)_2O(CH_2)_2\}$
$C(O)O^{\ominus}$ $H_2N^{\oplus}\{CH_2(CH_2)_2CH_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{CH_2(CH_2)_2CH_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{CH_2(CH_2)_2CH_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{CH_2(CH_2)_2CH_2\}$
$C(O)O^{\ominus}$ $HN^{\oplus}(Et)_3$	$C(O)O^{\ominus}$ $HN^{\oplus}(Et)_3$	$C(O)O^{\ominus}$ $HN^{\oplus}(Et)_3$	$C(O)O^{\ominus}$ $HN^{\oplus}(Et)_3$
$C(O)O^{\ominus}$ $N^{\oplus}(Me)_4$	$C(O)O^{\ominus}$ $N^{\oplus}(Me)_4$	$C(O)O^{\ominus}$ $N^{\oplus}(Me)_4$	$C(O)O^{\ominus}$ $N^{\oplus}(Me)_4$
$C(O)O^{\ominus}$ $N^{\oplus}(Me)_3CH_2Ph$	$C(O)O^{\ominus}$ $N^{\oplus}(Me)_3CH_2Ph$	$C(O)O^{\ominus}$ $N^{\oplus}(Me)_3CH_2Ph$	$C(O)O^{\ominus}$ $N^{\oplus}(Me)_3CH_2Ph$
$C(O)O^{\ominus}$ $S^{\oplus}(Me)_3$	$C(O)O^{\ominus}$ $S^{\oplus}(Me)_3$	$C(O)O^{\ominus}$ $S^{\oplus}(Me)_3$	$C(O)O^{\ominus}$ $S^{\oplus}(Me)_3$
$C(O)O^{\ominus}$ $K^{\oplus}$	$C(O)O^{\ominus}$ $K^{\oplus}$	$C(O)O^{\ominus}$ $K^{\oplus}$	$C(O)O^{\ominus}$ $K^{\oplus}$

R^1 is 4-Cl-Ph; R^3 is Cl.	R^1 is 4-Cl-Ph; R^3 is F.	R^1 is 4-Cl-Ph; R^3 is Br.	R^1 is 4-Cl-Ph; R^3 is I.
<u>R^2</u>	<u>R^2</u>	<u>R^2</u>	<u>R^2</u>
CO_2H	CO_2H	CO_2H	CO_2H
CO_2Me	CO_2Me	CO_2Me	CO_2Me
CO_2Et	CO_2Et	CO_2Et	CO_2Et
CO_2Pr	CO_2Pr	CO_2Pr	CO_2Pr
CO_2*i*Pr	CO_2*i*Pr	CO_2*i*Pr	CO_2*i*Pr
CO_2*t*-Bu	CO_2*t*-Bu	CO_2*t*-Bu	CO_2*t*-Bu
CO_2cyclohexyl	CO_2cyclohexyl	CO_2cyclohexyl	CO_2cyclohexyl
CO_2hexyl	CO_2hexyl	CO_2hexyl	CO_2hexyl
CO_2CH_2cyclohexyl	CO_2CH_2cyclohexyl	CO_2CH_2cyclohexyl	CO_2CH_2cyclohexyl
CO_2CH_2Ph	CO_2CH_2Ph	CO_2CH_2Ph	CO_2CH_2Ph
$CO_2CH(Me)Ph$	$CO_2CH(Me)Ph$	$CO_2CH(Me)Ph$	$CO_2CH(Me)Ph$
CO_2CH_2(4-Cl-Ph)	CO_2CH_2(4-Cl-Ph)	CO_2CH_2(4-Cl-Ph)	CO_2CH_2(4-Cl-Ph)
CO_2CH_2(3-F-Ph)	CO_2CH_2(3-F-Ph)	CO_2CH_2(3-F-Ph)	CO_2CH_2(3-F-Ph)
$CO_2CH_2CH_2NMe_2$	$CO_2CH_2CH_2NMe_2$	$CO_2CH_2CH_2NMe_2$	$CO_2CH_2CH_2NMe_2$
$CO_2CH_2CH_2OMe$	$CO_2CH_2CH_2OMe$	$CO_2CH_2CH_2OMe$	$CO_2CH_2CH_2OMe$

$CO_2CH_2CH_2OH$	$CO_2CH_2CH_2OH$	$CO_2CH_2CH_2OH$	$CO_2CH_2CH_2OH$
CO_2CH_2(3-oxetanyl)	CO_2CH_2(3-oxetanyl)	CO_2CH_2(3-oxetanyl)	CO_2CH_2(3-oxetanyl)
CH_2OH	CH_2OH	CH_2OH	CH_2OH
CH_2OMe	CH_2OMe	CH_2OMe	CH_2OMe
CH_2CO_2Me	CH_2CO_2Me	CH_2CO_2Me	CH_2CO_2Me
$CH(OH)CO_2Me$	$CH(OH)CO_2Me$	$CH(OH)CO_2Me$	$CH(OH)CO_2Me$
CHO	CHO	CHO	CHO
$CH(OC(=O)Me)CO_2Me$	$CH(OC(=O)Me)CO_2Me$	$CH(OC(=O)Me)CO_2Me$	$CH(OC(=O)Me)CO_2Me$
C(=NOH)H	C(=NOH)H	C(=NOH)H	C(=NOH)H
C(=NOMe)H	C(=NOMe)H	C(=NOMe)H	C(=NOMe)H
$C(=O)NH_2$	$C(=O)NH_2$	$C(=O)NH_2$	$C(=O)NH_2$
C(=O)NHMe	C(=O)NHMe	C(=O)NHMe	C(=O)NHMe
$C(=O)NMe_2$	$C(=O)NMe_2$	$C(=O)NMe_2$	$C(=O)NMe_2$
CO_2Ph	CO_2Ph	CO_2Ph	CO_2Ph
$C(O)O^{\ominus}\ H_3N^{\oplus}Me$	$C(O)O^{\ominus}\ H_3N^{\oplus}Me$	$C(O)O^{\ominus}\ H_3N^{\oplus}Me$	$C(O)O^{\ominus}\ H_3N^{\oplus}Me$
$C(O)O^{\ominus}\ H_3N^{\oplus}i\text{-}Pr$	$C(O)O^{\ominus}\ H_3N^{\oplus}i\text{-}Pr$	$C(O)O^{\ominus}\ H_3N^{\oplus}i\text{-}Pr$	$C(O)O^{\ominus}\ H_3N^{\oplus}i\text{-}Pr$
$C(O)O^{\ominus}\ H_3N^{\oplus}Pr$	$C(O)O^{\ominus}\ H_3N^{\oplus}Pr$	$C(O)O^{\ominus}\ H_3N^{\oplus}Pr$	$C(O)O^{\ominus}\ H_3N^{\oplus}Pr$
$C(O)O^{\ominus}\ H_3N^{\oplus}$butyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$butyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$butyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$butyl
$C(O)O^{\ominus}\ H_3N^{\oplus}$hexyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$hexyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$hexyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$hexyl
$C(O)O^{\ominus}\ H_3N^{\oplus}$octyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$octyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$octyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$octyl
$C(O)O^{\ominus}\ H_3N^{\oplus}$hexadecyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$hexadecyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$hexadecyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$hexadecyl
$C(O)O^{\ominus}\ H_3N^{\oplus}$octadecyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$octadecyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$octadecyl	$C(O)O^{\ominus}\ H_3N^{\oplus}$octadecyl
$C(O)O^{\ominus}H_3N^{\oplus}$cyclohexyl	$C(O)O^{\ominus}H_3N^{\oplus}$cyclohexyl	$C(O)O^{\ominus}H_3N^{\oplus}$cyclohexyl	$C(O)O^{\ominus}H_3N^{\oplus}$cyclohexyl
$C(O)O^{\ominus}\ H_2N^{\oplus}(Et)_2$	$C(O)O^{\ominus}\ H_2N^{\oplus}(Et)_2$	$C(O)O^{\ominus}\ H_2N^{\oplus}(Et)_2$	$C(O)O^{\ominus}\ H_2N^{\oplus}(Et)_2$
$C(O)O^{\ominus}$ $H_2N^{\oplus}\{(CH_2)_2O(CH_2)_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{(CH_2)_2O(CH_2)_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{(CH_2)_2O(CH_2)_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{(CH_2)_2O(CH_2)_2\}$
$C(O)O^{\ominus}$ $H_2N^{\oplus}\{CH_2(CH_2)_2CH_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{CH_2(CH_2)_2CH_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{CH_2(CH_2)_2CH_2\}$	$C(O)O^{\ominus}$ $H_2N^{\oplus}\{CH_2(CH_2)_2CH_2\}$
$C(O)O^{\ominus}\ HN^{\oplus}(Et)_3$	$C(O)O^{\ominus}\ HN^{\oplus}(Et)_3$	$C(O)O^{\ominus}\ HN^{\oplus}(Et)_3$	$C(O)O^{\ominus}\ HN^{\oplus}(Et)_3$
$C(O)O^{\ominus}\ N^{\oplus}(Me)_4$	$C(O)O^{\ominus}\ N^{\oplus}(Me)_4$	$C(O)O^{\ominus}\ N^{\oplus}(Me)_4$	$C(O)O^{\ominus}\ N^{\oplus}(Me)_4$
$C(O)O^{\ominus}\ N^{\oplus}(Me)_3CH_2Ph$	$C(O)O^{\ominus}\ N^{\oplus}(Me)_3CH_2Ph$	$C(O)O^{\ominus}\ N^{\oplus}(Me)_3CH_2Ph$	$C(O)O^{\ominus}\ N^{\oplus}(Me)_3CH_2Ph$
$C(O)O^{\ominus}\ S^{\oplus}(Me)_3$	$C(O)O^{\ominus}\ S^{\oplus}(Me)_3$	$C(O)O^{\ominus}\ S^{\oplus}(Me)_3$	$C(O)O^{\ominus}\ S^{\oplus}(Me)_3$
$C(O)O^{\ominus}\ K^{\oplus}$	$C(O)O^{\ominus}\ K^{\oplus}$	$C(O)O^{\ominus}\ K^{\oplus}$	$C(O)O^{\ominus}\ K^{\oplus}$

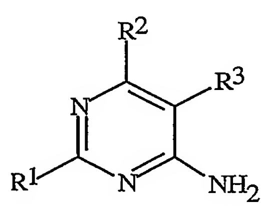
TABLE 2



R^2 is CO_2H; R^3 is Cl.	R^2 is CO_2Me; R^3 is Cl.	R^2 is CO_2Et; R^3 is Cl.
R^1	R^1	R^1
i-Pr	*i*-Pr	*i*-Pr
1-Me-cyclopropyl	1-Me-cyclopropyl	1-Me-cyclopropyl
2-Me-cyclopropyl	2-Me-cyclopropyl	2-Me-cyclopropyl
2-F-cyclopropyl	2-F-cyclopropyl	2-F-cyclopropyl
2-Cl-cyclopropyl	2-Cl-cyclopropyl	2-Cl-cyclopropyl
2,2-di-F-cyclopropyl	2,2-di-F-cyclopropyl	2,2-di-F-cyclopropyl
2,2-di-Cl-cyclopropyl	2,2-di-Cl-cyclopropyl	2,2-di-Cl-cyclopropyl
1,2-di-F-cyclopropyl	1,2-di-F-cyclopropyl	1,2-di-F-cyclopropyl
2,2,3,3-tetra-F-cyclopropyl	2,2,3,3-tetra-F-cyclopropyl	2,2,3,3-tetra-F-cyclopropyl
1,2,2,3,3-penta-F-cyclopropyl	1,2,2,3,3-penta-F-cyclopropyl	1,2,2,3,3-penta-F-cyclopropyl
Ph	Ph	Ph
4-Cl-Ph	4-Cl-Ph	4-Cl-Ph
4-F-Ph	4-F-Ph	4-F-Ph
3-OMe-Ph	3-OMe-Ph	3-OMe-Ph
4-Br-Ph	4-Br-Ph	4-Br-Ph
4-I-Ph	4-I-Ph	4-I-Ph
4-CF_3-Ph	4-CF_3-Ph	4-CF_3-Ph
4-$OCHF_2$-Ph	4-$OCHF_2$-Ph	4-$OCHF_2$-Ph
4-OCF_3-Ph	4-OCF_3-Ph	4-OCF_3-Ph
4-SCF_3-Ph	4-SCF_3-Ph	4-SCF_3-Ph
4-$SCHF_2$-Ph	4-$SCHF_2$-Ph	4-$SCHF_2$-Ph
4-CN-Ph	4-CN-Ph	4-CN-Ph
4-CO_2Me-Ph	4-CO_2Me-Ph	4-CO_2Me-Ph
2,4-di-Cl-Ph	2,4-di-Cl-Ph	2,4-di-Cl-Ph
2-F-4-Cl-Ph	2-F-4-Cl-Ph	2-F-4-Cl-Ph
3,4-di-Cl-Ph	3,4-di-Cl-Ph	3,4-di-Cl-Ph
2-MeO-cyclopropyl	2-MeO-cyclopropyl	2-MeO-cyclopropyl
2-MeS-cyclopropyl	2-MeS-cyclopropyl	2-MeS-cyclopropyl
$CH(Me)CH_2OMe$	$CH(Me)CH_2OMe$	$CH(Me)CH_2OMe$

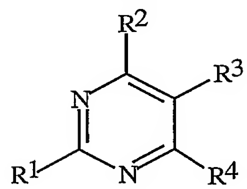
R^2 is CO_2H; R^3 is Br.	R^2 is CO_2Me; R^3 is Br.	R^2 is CO_2Et; R^3 is Br.
R^1	R^1	R^1
i-Pr	*i*-Pr	*i*-Pr
1-Me-cyclopropyl	1-Me-cyclopropyl	1-Me-cyclopropyl
2-Me-cyclopropyl	2-Me-cyclopropyl	2-Me-cyclopropyl
2-F-cyclopropyl	2-F-cyclopropyl	2-F-cyclopropyl
2-Cl-cyclopropyl	2-Cl-cyclopropyl	2-Cl-cyclopropyl
2,2-di-F-cyclopropyl	2,2-di-F-cyclopropyl	2,2-di-F-cyclopropyl
2,2-di-Cl-cyclopropyl	2,2-di-Cl-cyclopropyl	2,2-di-Cl-cyclopropyl
1,2-di-F-cyclopropyl	1,2-di-F-cyclopropyl	1,2-di-F-cyclopropyl
2,2,3,3-tetra-F-cyclopropyl	2,2,3,3-tetra-F-cyclopropyl	2,2,3,3-tetra-F-cyclopropyl
1,2,2,3,3-penta-F-cyclopropyl	1,2,2,3,3-penta-F-cyclopropyl	1,2,2,3,3-penta-F-cyclopropyl
Ph	Ph	Ph
4-Cl-Ph	4-Cl-Ph	4-Cl-Ph
4-F-Ph	4-F-Ph	4-F-Ph
3-OMe-Ph	3-OMe-Ph	3-OMe-Ph
4-Br-Ph	4-Br-Ph	4-Br-Ph
4-I-Ph	4-I-Ph	4-I-Ph
4-CF_3-Ph	4-CF_3-Ph	4-CF_3-Ph
4-$OCHF_2$-Ph	4-$OCHF_2$-Ph	4-$OCHF_2$-Ph
4-OCF_3-Ph	4-OCF_3-Ph	4-OCF_3-Ph
4-SCF_3-Ph	4-SCF_3-Ph	4-SCF_3-Ph
4-$SCHF_2$-Ph	4-$SCHF_2$-Ph	4-$SCHF_2$-Ph
4-CN-Ph	4-CN-Ph	4-CN-Ph
4-CO_2Me-Ph	4-CO_2Me-Ph	4-CO_2Me-Ph
2,4-di-Cl-Ph	2,4-di-Cl-Ph	2,4-di-Cl-Ph
2-F-4-Cl-Ph	2-F-4-Cl-Ph	2-F-4-Cl-Ph
3,4-di-Cl-Ph	3,4-di-Cl-Ph	3,4-di-Cl-Ph
2-MeO-cyclopropyl	2-MeO-cyclopropyl	2-MeO-cyclopropyl
2-MeS-cyclopropyl	2-MeS-cyclopropyl	2-MeS-cyclopropyl
$CH(Me)CH_2OMe$	$CH(Me)CH_2OMe$	$CH(Me)CH_2OMe$

TABLE 3



R^1 is cyclopropyl; R^2 is CO_2Me.	R^1 is cyclopropyl; R^2 is CO_2Et.
R^3	R^3
CN	CN
NO_2	NO_2
OMe	OMe
SMe	SMe
NH_2	NH_2
NHMe	NHMe
NMe_2	NMe_2

TABLE 4



R^1 is cyclopropyl; R^2 is CO_2Me; R^3 is Cl.	R^1 is cyclopropyl; R^2 is CO_2Me; R^3 is Br.	R^1 is cyclopropyl; R^2 is CO_2Et; R^3 is Cl.	R^1 is cyclopropyl; R^2 is CO_2Et; R^3 is Br.
R^4	R^4	R^4	R^4
NO_2	NO_2	NO_2	NO_2
NHMe	NHMe	NHMe	NHMe
NMe_2	NMe_2	NMe_2	NMe_2
$N\{CH_2CH_2OCH_2CH_2\}$	$N\{CH_2CH_2OCH_2CH_2\}$	$N\{CH_2CH_2OCH_2CH_2\}$	$N\{CH_2CH_2OCH_2CH_2\}$
NHC(=O)Me	NHC(=O)Me	NHC(=O)Me	NHC(=O)Me
NHC(=O)OMe	NHC(=O)OMe	NHC(=O)OMe	NHC(=O)OMe
$NHS(O)_2Me$	$NHS(O)_2Me$	$NHS(O)_2Me$	$NHS(O)_2Me$
$NHNH_2$	$NHNH_2$	$NHNH_2$	$NHNH_2$
$NHNO_2$	$NHNO_2$	$NHNO_2$	$NHNO_2$
$N{=}CHNMe_2$	$N{=}CHNMe_2$	$N{=}CHNMe_2$	$N{=}CHNMe_2$
NHOH	NHOH	NHOH	NHOH
NHOMe	NHOMe	NHOMe	NHOMe
$NHCH_2CO_2Me$	$NHCH_2CO_2Me$	$NHCH_2CO_2Me$	$NHCH_2CO_2Me$
$NHCH_2CO_2Et$	$NHCH_2CO_2Et$	$NHCH_2CO_2Et$	$NHCH_2CO_2Et$
$NHCH_2CH_2OH$	$NHCH_2CH_2OH$	$NHCH_2CH_2OH$	$NHCH_2CH_2OH$
$NHCH_2CH_2OMe$	$NHCH_2CH_2OMe$	$NHCH_2CH_2OMe$	$NHCH_2CH_2OMe$
$NHCH_2CH_2NMe_2$	$NHCH_2CH_2NMe_2$	$NHCH_2CH_2NMe_2$	$NHCH_2CH_2NMe_2$

R^1 is 4-Cl-Ph; R^2 is CO_2Me; R^3 is Cl.	R^1 is 4-Cl-Ph; R^2 is CO_2Me; R^3 is Br.	R^1 is 4-Cl-Ph; R^2 is CO_2Et; R^3 is Cl.	R^1 is 4-Cl-Ph; R^2 is CO_2Et; R^3 is Br.
R^4	R^4	R^4	R^4
NO_2	NO_2	NO_2	NO_2
NHMe	NHMe	NHMe	NHMe
NMe_2	NMe_2	NMe_2	NMe_2
$N\{CH_2CH_2OCH_2CH_2\}$	$N\{CH_2CH_2OCH_2CH_2\}$	$N\{CH_2CH_2OCH_2CH_2\}$	$N\{CH_2CH_2OCH_2CH_2\}$
NHC(=O)Me	NHC(=O)Me	NHC(=O)Me	NHC(=O)Me
NHC(=O)OMe	NHC(=O)OMe	NHC(=O)OMe	NHC(=O)OMe
$NHS(O)_2Me$	$NHS(O)_2Me$	$NHS(O)_2Me$	$NHS(O)_2Me$
$NHNH_2$	$NHNH_2$	$NHNH_2$	$NHNH_2$
$NHNO_2$	$NHNO_2$	$NHNO_2$	$NHNO_2$
$N{=}CHNMe_2$	$N{=}CHNMe_2$	$N{=}CHNMe_2$	$N{=}CHNMe_2$
NHOH	NHOH	NHOH	NHOH
NHOMe	NHOMe	NHOMe	NHOMe
$NHCH_2CO_2Me$	$NHCH_2CO_2Me$	$NHCH_2CO_2Me$	$NHCH_2CO_2Me$
$NHCH_2CO_2Et$	$NHCH_2CO_2Et$	$NHCH_2CO_2Et$	$NHCH_2CO_2Et$
$NHCH_2CH_2OH$	$NHCH_2CH_2OH$	$NHCH_2CH_2OH$	$NHCH_2CH_2OH$
$NHCH_2CH_2OMe$	$NHCH_2CH_2OMe$	$NHCH_2CH_2OMe$	$NHCH_2CH_2OMe$
$NHCH_2CH_2NMe_2$	$NHCH_2CH_2NMe_2$	$NHCH_2CH_2NMe_2$	$NHCH_2CH_2NMe_2$

Formulation/Utility

Compounds of this invention will generally be used as a formulation or composition with an agriculturally suitable carrier comprising at least one of a liquid diluent, a solid diluent or a surfactant. The formulation or composition ingredients are selected to be consistent with the physical properties of the active ingredient, mode of application and environmental factors such as soil type, moisture and temperature. Useful formulations include liquids such as solutions (including emulsifiable concentrates), suspensions, emulsions (including microemulsions and/or suspoemulsions) and the like which optionally can be thickened into gels. Useful formulations further include solids such as dusts, powders, granules, pellets, tablets, films (including seed coatings), and the like which can be water-dispersible ("wettable") or water-soluble. Active ingredient can be (micro)encapsulated and further formed into a suspension or solid formulation; alternatively the entire formulation of active ingredient can be encapsulated (or "overcoated"). Encapsulation can control or delay release of the active ingredient. Sprayable formulations can be extended in suitable media and used at spray volumes from about one to several hundred liters per hectare. High-strength compositions are primarily used as intermediates for further formulation.

The formulations will typically contain effective amounts of active ingredient, diluent and surfactant within the following approximate ranges which add up to 100 percent by weight.

	Weight Percent		
	Active Ingredient	Diluent	Surfactant
Water-Dispersible and Water-soluble Granules, Tablets and Powders.	0.001–90	0–99.999	0–15
Suspensions, Emulsions, Solutions (including Emulsifiable Concentrates)	1–50	40–99	0–50
Dusts	1–25	70–99	0–5
Granules and Pellets	0.001–99	5–99.999	0–15
High Strength Compositions	90–99	0–10	0–2

Typical solid diluents are described in Watkins, et al., *Handbook of Insecticide Dust Diluents and Carriers*, 2nd Ed., Dorland Books, Caldwell, New Jersey. Typical liquid diluents are described in Marsden, *Solvents Guide*, 2nd Ed., Interscience, New York, 1950. *McCutcheon's Detergents and Emulsifiers Annual*, Allured Publ. Corp., Ridgewood, New Jersey, as well as Sisely and Wood, *Encyclopedia of Surface Active Agents*, Chemical Publ. Co., Inc., New York, 1964, list surfactants and recommended uses. All formulations can contain minor amounts of additives to reduce foam, caking, corrosion, microbiological growth and the like, or thickeners to increase viscosity.

Surfactants include, for example, polyethoxylated alcohols, polyethoxylated alkylphenols, polyethoxylated sorbitan fatty acid esters, dialkyl sulfosuccinates, alkyl sulfates, alkylbenzene sulfonates, organosilicones, *N,N*-dialkyltaurates, lignin sulfonates, naphthalene sulfonate formaldehyde condensates, polycarboxylates, glycerol esters, polyoxyethylene/polyoxypropylene block copolymers, and alkylpolyglycosides where the number of glucose units, referred to as degree of polymerization (D.P.), can range from 1 to 3 and the alkyl units can range from C_6 to C_{14} (see *Pure and Applied Chemistry 72*, 1255–1264). Solid diluents include, for example, clays such as bentonite, montmorillonite, attapulgite and kaolin, starch, sugar, silica, talc, diatomaceous earth, urea, calcium carbonate, sodium carbonate and bicarbonate, and sodium sulfate. Liquid diluents include, for example, water, *N,N*-dimethylformamide, dimethyl sulfoxide, *N*-alkylpyrrolidone, ethylene glycol, polypropylene glycol, propylene carbonate, dibasic esters, paraffins, alkylbenzenes, alkylnaphthalenes, glycerine, triacetine, oils of olive, castor, linseed, tung, sesame, corn, peanut, cotton-seed, soybean, rape-seed and coconut, fatty acid esters, ketones such as cyclohexanone, 2-heptanone, isophorone and 4-hydroxy-4-methyl-2-pentanone, acetates

such as hexyl acetate, heptyl acetate and octyl acetate, and alcohols such as methanol, cyclohexanol, decanol, benzyl and tetrahydrofurfuryl alcohol.

Useful formulations of this invention may also contain materials well known to those skilled in the art as formulation aids such as antifoams, film formers and dyes. Antifoams can include water dispersible liquids comprising polyorganosiloxanes like Rhodorsil® 416. The film formers can include polyvinyl acetates, polyvinyl acetate copolymers, polyvinylpyrrolidone-vinyl acetate copolymer, polyvinyl alcohols, polyvinyl alcohol copolymers and waxes. Dyes can include water dispersible liquid colorant compositions like Pro-lzed® Colorant Red. One skilled in the art will appreciate that this is a non-exhaustive list of formulation aids. Suitable examples of formulation aids include those listed herein and those listed in *McCutcheon's 2001, Volume 2: Functional Materials* published by MC Publishing Company and PCT Publication WO 03/024222.

Solutions, including emulsifiable concentrates, can be prepared by simply mixing the ingredients. Dusts and powders can be prepared by blending and, usually, grinding as in a hammer mill or fluid-energy mill. Suspensions are usually prepared by wet-milling; see, for example, U.S. 3,060,084. Granules and pellets can be prepared by spraying the active material upon preformed granular carriers or by agglomeration techniques. See Browning, "Agglomeration", *Chemical Engineering*, December 4, 1967, pp 147–48, *Perry's Chemical Engineer's Handbook*, 4th Ed., McGraw-Hill, New York, 1963, pages 8–57 and following, and WO 91/13546. Pellets can be prepared as described in U.S. 4,172,714. Water-dispersible and water-soluble granules can be prepared as taught in U.S. 4,144,050, U.S. 3,920,442 and DE 3,246,493. Tablets can be prepared as taught in U.S. 5,180,587, U.S. 5,232,701 and U.S. 5,208,030. Films can be prepared as taught in GB 2,095,558 and U.S. 3,299,566.

For further information regarding the art of formulation, see T. S. Woods, "The Formulator's Toolbox – Product Forms for Modern Agriculture" in *Pesticide Chemistry and Bioscience, The Food–Environment Challenge*, T. Brooks and T. R. Roberts, Eds., Proceedings of the 9th International Congress on Pesticide Chemistry, The Royal Society of Chemistry, Cambridge, 1999, pp. 120–133. See also U.S. 3,235,361, Col. 6, line 16 through Col. 7, line 19 and Examples 10–41; U.S. 3,309,192, Col. 5, line 43 through Col. 7, line 62 and Examples 8, 12, 15, 39, 41, 52, 53, 58, 132, 138–140, 162–164, 166, 167 and 169–182; U.S. 2,891,855, Col. 3, line 66 through Col. 5, line 17 and Examples 1–4; Klingman, *Weed Control as a Science*, John Wiley and Sons, Inc., New York, 1961, pp 81–96; Hance et al., *Weed Control Handbook*, 8th Ed., Blackwell Scientific Publications, Oxford, 1989; and *Developments in formulation technology*, PJB Publications, Richmond, UK, 2000.

In the following Examples, all percentages are by weight and all formulations are prepared in conventional ways. Compound numbers refer to compounds in Index Tables A–D.

Example A

High Strength Concentrate

Compound 1	98.5%
silica aerogel	0.5%
synthetic amorphous fine silica	1.0%.

Example B

Wettable Powder

Compound 2	65.0%
dodecylphenol polyethylene glycol ether	2.0%
sodium ligninsulfonate	4.0%
sodium silicoaluminate	6.0%
montmorillonite (calcined)	23.0%.

Example C

Granule

Compound 4	10.0%
attapulgite granules (low volatile matter, 0.71/0.30 mm; U.S.S. No. 25–50 sieves)	90.0%.

Example D

Aqueous Suspension

Compound 9	25.0%
hydrated attapulgite	3.0%
crude calcium ligninsulfonate	10.0%
sodium dihydrogen phosphate	0.5%
water	61.5%.

Example E

Extruded Pellet

Compound 1	25.0%
anhydrous sodium sulfate	10.0%
crude calcium ligninsulfonate	5.0%
sodium alkylnaphthalenesulfonate	1.0%
calcium/magnesium bentonite	59.0%.

Example F

Microemulsion

Compound 2	1.0%
triacetine	30.0%
C_8–C_{10} alkylpolyglycoside	30.0%
glyceryl monooleate	19.0%
water	20.0%.

Example G

Wettable Powder

Compound 9	65.0%
dodecylphenol polyethylene glycol ether	2.0%
sodium ligninsulfonate	4.0%
sodium silicoaluminate	6.0%
montmorillonite (calcined)	23.0%.

Test results indicate that the compounds of the present invention are highly active preemergent and/or postemergent herbicides and/or plant growth regulants. Many of them have utility for broad-spectrum pre- and/or postemergence weed control in areas where complete control of all vegetation is desired such as around fuel storage tanks, industrial storage areas, parking lots, drive-in theaters, air fields, river banks, irrigation and other waterways, around billboards and highway and railroad structures. Many of the compounds of this invention, by virtue of selective metabolism in crops versus weeds, or by selective activity at the locus of physiological inhibition in crops and weeds, or by selective placement on or within the environment of a mixture of crops and weeds, are useful for the selective control of grass and broadleaf weeds within a crop/weed mixture. One skilled in the art will recognize that the preferred combination of these selectivity factors within a compound or group of compounds can readily be determined by performing routine biological and/or biochemical assays. Compounds of this invention may show tolerance to important agronomic crops including, but is not limited to, alfalfa, barley, cotton, wheat, rape, sugar beets, corn (maize), sorghum, soybeans, rice, oats, peanuts, vegetables, tomato, potato, perennial plantation crops including coffee, cocoa, oil palm, rubber, sugarcane, citrus, grapes, fruit trees, nut trees, banana, plantain, pineapple, hops, tea and forests such as eucalyptus and conifers (e.g., loblolly pine), and turf species (e.g., Kentucky bluegrass, St. Augustine grass, Kentucky fescue and Bermuda grass). Compounds of this invention can be used in crops genetically transformed or bred to incorporate resistance to herbicides, express proteins toxic to invertebrate pests (such as *Bacillus thuringiensis* toxin), and/or express other useful traits. Those skilled in the art will appreciate that not all compounds are equally

effective against all weeds. Alternatively, the subject compounds are useful to modify plant growth.

As the compounds of the invention have both preemergent and postemergent herbicidal activity, to control undesired vegetation by killing or injuring the vegetation or reducing its growth, the compounds can be usefully applied by a variety of methods involving contacting a herbicidally effective amount of a compound of the invention, or a composition comprising said compound and at least one of a surfactant, a solid diluent or a liquid diluent, to the foliage or other part of the undesired vegetation or to the environment of the undesired vegetation such as the soil or water in which the undesired vegetation is growing or which surrounds the seed or other propagule of the undesired vegetation.

A herbicidally effective amount of the compounds of this invention is determined by a number of factors. These factors include: formulation selected, method of application, amount and type of vegetation present, growing conditions, etc. In general, a herbicidally effective amount of compounds of this invention is about 0.0001 to 20 kg/ha with a preferred range of about 0.001 to 5 kg/ha and a more preferred range of about 0.004 to 3 kg/ha. One skilled in the art can easily determine the herbicidally effective amount necessary for the desired level of weed control.

Compounds of this invention can be used alone or in combination with other herbicides, insecticides and fungicides, and other agricultural chemicals such as fertilizers. Mixtures of the compounds of the invention with other herbicides can broaden the spectrum of activity against additional weed species, and suppress the proliferation of any resistant biotypes. A mixture of one or more of the following herbicides with a compound of this invention may be particularly useful for weed control: acetochlor, acifluorfen and its sodium salt, aclonifen, acrolein (2-propenal), alachlor, alloxydim, ametryn, amicarbazone, amidosulfuron, aminopyralid, amitrole, ammonium sulfamate, anilofos, asulam, atrazine, azimsulfuron, beflubutamid, benazolin, benazolin-ethyl, benfluralin, benfuresate, bensulfuron-methyl, bensulide, bentazone, benzobicyclon, benzofenap, bifenox, bilanafos, bispyribac and its sodium salt, bromacil, bromobutide, bromofenoxim, bromoxynil, bromoxynil octanoate, butachlor, butafenacil, butamifos, butralin, butroxydim, butylate, cafenstrole, carbetamide, carfentrazone-ethyl, catechin, chlomethoxyfen, chloramben, chlorbromuron, chlorflurenol-methyl, chloridazon, chlorimuron-ethyl, chlorotoluron, chlorpropham, chlorsulfuron, chlorthal-dimethyl, chlorthiamid, cinidon-ethyl, cinmethylin, cinosulfuron, clefoxydim, clethodim, clodinafop-propargyl, clomazone, clomeprop, clopyralid, clopyralid-olamine, cloransulam-methyl, copper sulfate, CUH-35 (2-methoxyethyl 2-[[[4-chloro-2-fluoro-5-[(1-methyl-2-propynyl)oxy]phenyl](3-fluorobenzoyl)amino]carbonyl]-1-cyclohexene-1-carboxylate), cumyluron, cyanazine, cycloate, cyclosulfamuron, cycloxydim, cyhalofop-butyl, 2,4-D and its butotyl, butyl, isoctyl and isopropyl esters and its dimethylammonium, diolamine and trolamine salts, daimuron,

dalapon, dalapon-sodium, dazomet, 2,4-DB and its dimethylammonium, potassium and sodium salts, desmedipham, desmetryn, dicamba and its diglycolammonium, dimethylammonium, potassium and sodium salts, dichlobenil, dichlorprop, diclofop-methyl, diclosulam, difenzoquat metilsulfate, diflufenican, diflufenzopyr, dimefuron, dimepiperate, dimethachlor, dimethametryn, dimethenamid, dimethenamid-P, dimethipin, dimethylarsinic acid and its sodium salt, dinitramine, dinoterb, diphenamid, diquat dibromide, dithiopyr, diuron, DNOC, endothal, epoprodan, EPTC, esprocarb, ethalfluralin, ethametsulfuron-methyl, ethofumesate, ethoxyfen, ethoxysulfuron, etobenzanid, fenoxaprop-ethyl, fenoxaprop-P-ethyl, fentrazamide, fenuron, fenuron-TCA, flamprop-methyl, flamprop-M-isopropyl, flamprop-M-methyl, flazasulfuron, florasulam, fluazifop-butyl, fluazifop-P-butyl, flucarbazone, flucarbazone-sodium, flucetosulfuron, fluchloralin, flufenacet, flufenpyr, flufenpyr-ethyl, flumetsulam, flumiclorac-pentyl, flumioxazin, fluometuron, fluoroglycofen-ethyl, flupyrsulfuron-methyl and its sodium salt, flurenol, flurenol-butyl, fluridone, flurochloridone, fluroxypyr, flurtamone, fluthiacet-methyl, fomesafen, foramsulfuron, fosamine-ammonium, glufosinate, glufosinate-ammonium, glyphosate and its salts such as ammonium, isopropylammonium, potassium, sodium (including sesquisodium) and trimesium (alternatively named sulfosate), halosulfuron-methyl, haloxyfop-etotyl, haloxyfop-methyl, hexazinone, HOK-201 (*N*-(2,4-difluorophenyl)-1,5-dihydro-*N*-(1-methylethyl)-5-oxo-1-[(tetrahydro-2*H*-pyran-2-yl)-methyl]-4*H*-1,2,4-triazole-4-carboxamide), imazamethabenz-methyl, imazamox, imazapic, imazapyr, imazaquin, imazaquin-ammonium, imazethapyr, imazethapyr-ammonium, imazosulfuron, indanofan, iodosulfuron-methyl, ioxynil, ioxynil octanoate, ioxynil-sodium, isoproturon, isouron, isoxaben, isoxaflutole, isoxachlortole, isoxadifen, KUH-021 (*N*-[2-[(4,6-dimethoxy-2-pyrimidinyl)hydroxymethyl]-6-(methoxymethyl)phenyl]-1,1-difluoro-methanesulfonamide), lactofen, lenacil, linuron, maleic hydrazide, MCPA and its salts (e.g., MCPA-dimethylammonium, MCPA-potassium and MCPA-sodium), esters (e.g., MCPA-2-ethylhexyl, MCPA-butotyl) and thioesters (e.g., MCPA-thioethyl), MCPB and its salts (e.g., MCPB-sodium) and esters (e.g., MCPB-ethyl), mecoprop, mecoprop-P, mefenacet, mefluidide, mesosulfuron-methyl, mesotrione, metam-sodium, metamifop, metamitron, metazachlor, methabenzthiazuron, methylarsonic acid and its calcium, monoammonium, monosodium and disodium salts, methyldymron, metobenzuron, metobromuron, metolachlor, S-metholachlor, metosulam, metoxuron, metribuzin, metsulfuron-methyl, molinate, monolinuron, naproanilide, napropamide, naptalam, neburon, nicosulfuron, norflurazon, orbencarb, oryzalin, oxadiargyl, oxadiazon, oxasulfuron, oxaziclomefone, oxyfluorfen, paraquat dichloride, pebulate, pelargonic acid, pendimethalin, penoxsulam, pentanochlor, pentoxazone, perfluidone, pethoxyamid, phenmedipham, picloram, picloram-potassium, picolinafen, pinoxaden, piperofos, pretilachlor, primisulfuron-methyl, prodiamine, profoxydim, prometon, prometryn, propachlor, propanil, propaquizafop,

propazine, propham, propisochlor, propoxycarbazone, propoxycarbazone-sodium, propyzamide, prosulfocarb, prosulfuron, pyraclonil, pyraflufen-ethyl, pyrazogyl, pyrazolate, pyrazolynate, pyrazoxyfen, pyrazosulfuron-ethyl, pyribenzoxim, pyributicarb, pyridate, pyriftalid, pyriminobac-methyl, pyrithiobac, pyrithiobac-sodium, quinclorac, quinmerac, quinoclamine, quizalofop-ethyl, quizalofop-P-ethyl, quizalofop-P-tefuryl, rimsulfuron, sethoxydim, siduron, simazine, simetryn, sulcotrione, sulfentrazone, sulfometuron-methyl, sulfosulfuron, 2,3,6-TBA, TCA, TCA-sodium, tebutam, tebuthiuron, tepraloxydim, terbacil, terbumeton, terbuthylazine, terbutryn, thenylchlor, thiazopyr, thifensulfuron-methyl, thiobencarb, tiocarbazil, tralkoxydim, tri-allate, triasulfuron, triaziflam, tribenuron-methyl, triclopyr, triclopyr-butotyl, triclopyr-triethylammonium, tridiphane, trietazine, trifloxysulfuron, trifluralin, triflusulfuron-methyl, tritosulfuron and vernolate. Other herbicides also include bioherbicides such as *Alternaria destruens* Simmons, *Colletotrichum gloeosporiodes* (Penz.) Penz. & Sacc., *Drechsiera monoceras* (MTB-951), *Myrothecium verrucaria* (Albertini & Schweinitz) Ditmar: Fries, *Phytophthora palmivora* (Butl.) Butl. and *Puccinia thlaspeos* Schub. Combinations of compounds of the invention with other herbicides can result in a greater-than-additive (i.e. synergistic) effect on weeds and/or a less-than-additive effect (i.e. safening) on crops or other desirable plants. In certain instances, combinations with other herbicides having a similar spectrum of control but a different mode of action will be particularly advantageous for preventing the development of resistant weeds. Herbicidally effective amounts of compounds of the invention as well as herbicidally effective amounts of other herbicides can be easily determined by one skilled in the art through simple experimentation.

Preferred for better control of undesired vegetation (e.g., lower use rate, broader spectrum of weeds controlled, or enhanced crop safety) or for preventing the development of resistant weeds are mixtures of a compound of this invention with a herbicide selected from the group consisting of diuron, hexazinone, terbacil, bromacil, glyphosate (particularly glyphosate-isopropylammonium, glyphosate-sodium, glyphosate-potassium, glyphosate-trimesium), glufosinate (particularly glufosinate-ammonium), azimsulfuron, chlorsulfuron, ethametsulfuron-methyl, chlorimuron-ethyl, bensulfuron-methyl, rimsulfuron, sulfometuron-methyl, metsulfuron-methyl, nicosulfuron, tribenuron-methyl, thifensulfuron-methyl, flupyrsulfuron-methyl, flupyrsulfuron-methyl-sodium, halosulfuron-methyl, primisulfuron-methyl, trifloxysulfuron, foramsulfuron, mesosulfuron-methyl, iodosulfuron-methyl, isoproturon, ametryn, amitrole, paraquat dichloride, diquat dibromide, atrazine, metribuzin, acetochlor, metolachlor, S-metolachlor, alachlor, pretilachlor, sethoxydim, tralkoxydim, clethodim, cyhalofop-butyl, quizalofop-ethyl, diclofop-methyl, clodinafop-propargyl, fenoxaprop-ethyl, dimethenamid, flufenacet, picloram, prodiamine, fosamine-ammonium, 2,4-D, 2,4-DB, dicamba, penoxsulam, flumetsulam, naptalam, pendimethalin, oryzalin, MCPA (and its dimethylammonium, potassium and sodium salts),

MCPA-isoctyl, MCPA-thioethyl mecoprop, clopyralid, aminopyralid, triclopyr, fluroxypyr, diflufenzopyr, imazapyr, imazethapyr, imazamox, picolinafen, oxyfluorfen, oxadiazon, carfentrazone-ethyl, sulfentrazone, flumioxazin, diflufenican, bromoxynil, propanil, thiobencarb, molinate, fluridone, mesotrione, sulcotrione, isoxaflutole, isoxaben, clomazone, anilofos, beflubutamid, benfuresate, bentazone, benzobicyclon, benzofenap, bromobutide, butachlor, butamifos, cafenstrole, clomeprop, dimepiperate, dimethametryn, daimuron, esprocarb, etobenzanide, fentrazamid, indanofan, cumylron, menfenacet, oxaziclomefone, oxadiargyl, pentoxazone, pyraclonil, pyrazolate, pyributicarb, pyriftalid, pyriminobac-methyl, thenylchlor, bispyribac-sodium, clefoxydim, copper sulfate, cinosulfuron, cyclosulfamuron, ethoxysulfuron, epoprodan, flucetosulfuron, imazosulfuron, metamifop, pyrazosulfuron-ethyl, quinclorac, flucarbazone-sodium, propoxycarbazone-sodium, amicarbazone, florasulam, triasulfuron, triaziflam, pinoxaden, tritosulfuron, amidosulfuron, metosulam, sulfosulfuron, pyraflufen-ethyl, HOK-201, KUH-021 and CUH-35. Specifically preferred mixtures (compound numbers refer to compounds in Index Tables A–D) are selected from the group: compound 4 and diuron; compound 9 and diuron; compound 58 and diuron; compound 64 and diuron; compound 65 (and salts thereof) and diuron; compound 94 and diuron; compound 95 (and salts thereof) and diuron; compound 96 and diuron; compound 135 (and salts thereof) and diuron; compound 4 and hexazinone; compound 9 and hexazinone; compound 58 and hexazinone; compound 64 and hexazinone; compound 65 (and salts thereof) and hexazinone; compound 94 and hexazinone; compound 95 (and salts thereof) and hexazinone; compound 96 and hexazinone; compound 135 (and salts thereof) and hexazinone; compound 4 and terbacil; compound 9 and terbacil; compound 58 and terbacil; compound 64 and terbacil; compound 65 (and salts thereof) and terbacil; compound 94 and terbacil; compound 95 (and salts thereof) and terbacil; compound 96 and terbacil; compound 135 (and salts thereof) and terbacil; compound 4 and bromacil; compound 9 and bromacil; compound 58 and bromacil; compound 64 and bromacil; compound 65 (and salts thereof) and bromacil; compound 94 and bromacil; compound 95 (and salts thereof) and bromacil; compound 96 and bromacil; compound 135 (and salts thereof) and bromacil; compound 4 and glyphosate; compound 9 and glyphosate; compound 58 and glyphosate; compound 64 and glyphosate; compound 65 (and salts thereof) and glyphosate; compound 94 and glyphosate; compound 95 (and salts thereof) and glyphosate; compound 96 and glyphosate; compound 135 (and salts thereof) and glyphosate; compound 4 and glufosinate; compound 9 and glufosinate; compound 58 and glufosinate; compound 64 and glufosinate; compound 65 (and salts thereof) and glufosinate; compound 94 and glufosinate; compound 95 (and salts thereof) and glufosinate; compound 96 and glufosinate; compound 135 (and salts thereof) and glufosinate; compound 4 and azimsulfuron; compound 9 and azimsulfuron; compound 58 and azimsulfuron; compound 64 and azimsulfuron; compound 65 (and salts thereof) and azimsulfuron; compound 94 and

azimsulfuron; compound 95 (and salts thereof) and azimsulfuron; compound 96 and azimsulfuron; compound 135 (and salts thereof) and azimsulfuron; compound 4 and chlorsulfuron; compound 9 and chlorsulfuron; compound 58 and chlorsulfuron; compound 64 and chlorsulfuron; compound 65 (and salts thereof) and chlorsulfuron; compound 94 and chlorsulfuron; compound 95 (and salts thereof) and chlorsulfuron; compound 96 and chlorsulfuron; compound 135 (and salts thereof) and chlorsulfuron; compound 4 and ethametsufuron-methyl; compound 9 and ethametsufuron-methyl; compound 58 and ethametsufuron-methyl; compound 64 and ethametsufuron-methyl; compound 65 (and salts thereof) and ethametsufuron-methyl; compound 94 and ethametsufuron-methyl; compound 95 (and salts thereof) and ethametsufuron-methyl; compound 96 and ethametsufuron-methyl; compound 135 (and salts thereof) and ethametsufuron-methyl; compound 4 and chlorimuron-ethyl; compound 9 and chlorimuron-ethyl; compound 58 and chlorimuron-ethyl; compound 64 and chlorimuron-ethyl; compound 65 (and salts thereof) and chlorimuron-ethyl; compound 94 and chlorimuron-ethyl; compound 95 (and salts thereof) and chlorimuron-ethyl; compound 96 and chlorimuron-ethyl; compound 135 (and salts thereof) and chlorimuron-ethyl; compound 4 and bensulfuron-methyl; compound 9 and bensulfuron-methyl; compound 58 and bensulfuron-methyl; compound 64 and bensulfuron-methyl; compound 65 (and salts thereof) and bensulfuron-methyl; compound 94 and bensulfuron-methyl; compound 95 (and salts thereof) and bensulfuron-methyl; compound 96 and bensulfuron-methyl; compound 135 (and salts thereof) and bensulfuron-methyl; compound 4 and rimsulfuron; compound 9 and rimsulfuron; compound 58 and rimsulfuron; compound 64 and rimsulfuron; compound 65 (and salts thereof) and rimsulfuron; compound 94 and rimsulfuron; compound 95 (and salts thereof) and rimsulfuron; compound 96 and rimsulfuron; compound 135 (and salts thereof) and rimsulfuron; compound 4 and sulfometuron-methyl; compound 9 and sulfometuron-methyl; compound 58 and sulfometuron-methyl; compound 64 and sulfometuron-methyl; compound 65 (and salts thereof) and sulfometuron-methyl; compound 94 and sulfometuron-methyl; compound 95 (and salts thereof) and sulfometuron-methyl; compound 96 and sulfometuron-methyl; compound 135 (and salts thereof) and sulfometuron-methyl; compound 4 and metsulfuron-methyl; compound 9 and metsulfuron-methyl; compound 58 and metsulfuron-methyl; compound 64 and metsulfuron-methyl; compound 65 (and salts thereof) and metsulfuron-methyl; compound 94 and metsulfuron-methyl; compound 95 (and salts thereof) and metsulfuron-methyl; compound 96 and metsulfuron-methyl; compound 135 (and salts thereof) and metsulfuron-methyl; compound 4 and nicosulfuron; compound 9 and nicosulfuron; compound 58 and nicosulfuron; compound 64 and nicosulfuron; compound 65 (and salts thereof) and nicosulfuron; compound 94 and nicosulfuron; compound 95 (and salts thereof) and nicosulfuron; compound 96 and nicosulfuron; compound 135 (and salts thereof) and nicosulfuron; compound 4 and tribenuron-methyl;

compound 9 and tribenuron-methyl; compound 58 and tribenuron-methyl; compound 64 and tribenuron-methyl; compound 65 (and salts thereof) and tribenuron-methyl; compound 94 and tribenuron-methyl; compound 95 (and salts thereof) and tribenuron-methyl; compound 96 and tribenuron-methyl; compound 135 (and salts thereof) and tribenuron-methyl; compound 4 and thifensulfuron-methyl; compound 9 and thifensulfuron-methyl; compound 58 and thifensulfuron-methyl; compound 64 and thifensulfuron-methyl; compound 65 (and salts thereof) and thifensulfuron-methyl; compound 94 and thifensulfuron-methyl; compound 95 (and salts thereof) and thifensulfuron-methyl; compound 96 and thifensulfuron-methyl; compound 135 (and salts thereof) and thifensulfuron-methyl; compound 4 and flupyrsulfuron-methyl; compound 9 and flupyrsulfuron-methyl; compound 58 and flupyrsulfuron-methyl; compound 64 and flupyrsulfuron-methyl; compound 65 (and salts thereof) and flupyrsulfuron-methyl; compound 94 and flupyrsulfuron-methyl; compound 95 (and salts thereof) and flupyrsulfuron-methyl; compound 96 and flupyrsulfuron-methyl; compound 135 (and salts thereof) and flupyrsulfuron-methyl; compound 4 and flupyrsulfuron-methyl-sodium; compound 9 and flupyrsulfuron-methyl-sodium; compound 58 and flupyrsulfuron-methyl-sodium; compound 64 and flupyrsulfuron-methyl-sodium; compound 65 (and salts thereof) and flupyrsulfuron-methyl-sodium; compound 94 and flupyrsulfuron-methyl-sodium; compound 95 (and salts thereof) and flupyrsulfuron-methyl-sodium; compound 96 and flupyrsulfuron-methyl-sodium; compound 135 (and salts thereof) and flupyrsulfuron-methyl-sodium; compound 4 and halosulfuron-methyl; compound 9 and halosulfuron-methyl; compound 58 and halosulfuron-methyl; compound 64 and halosulfuron-methyl; compound 65 (and salts thereof) and halosulfuron-methyl; compound 94 and halosulfuron-methyl; compound 95 (and salts thereof) and halosulfuron-methyl; compound 96 and halosulfuron-methyl; compound 135 (and salts thereof) and halosulfuron-methyl; compound 4 and primisulfuron-methyl; compound 9 and primisulfuron-methyl; compound 58 and primisulfuron-methyl; compound 64 and primisulfuron-methyl; compound 65 (and salts thereof) and primisulfuron-methyl; compound 94 and primisulfuron-methyl; compound 95 (and salts thereof) and primisulfuron-methyl; compound 96 and primisulfuron-methyl; compound 135 (and salts thereof) and primisulfuron-methyl; compound 4 and trifloxysulfuron; compound 9 and trifloxysulfuron; compound 58 and trifloxysulfuron; compound 64 and trifloxysulfuron; compound 65 (and salts thereof) and trifloxysulfuron; compound 94 and trifloxysulfuron; compound 95 (and salts thereof) and trifloxysulfuron; compound 96 and trifloxysulfuron; compound 135 (and salts thereof) and trifloxysulfuron; compound 4 and foramsulfuron; compound 9 and foramsulfuron; compound 58 and foramsulfuron; compound 64 and foramsulfuron; compound 65 (and salts thereof) and foramsulfuron; compound 94 and foramsulfuron; compound 95 (and salts thereof) and foramsulfuron; compound 96 and foramsulfuron; compound 135 (and salts thereof) and

foramsulfuron; compound 4 and mesosulfuron-methyl; compound 9 and mesosulfuron-methyl; compound 58 and mesosulfuron-methyl; compound 64 and mesosulfuron-methyl; compound 65 (and salts thereof) and mesosulfuron-methyl; compound 94 and mesosulfuron-methyl; compound 95 (and salts thereof) and mesosulfuron-methyl; compound 96 and mesosulfuron-methyl; compound 135 (and salts thereof) and mesosulfuron-methyl; compound 4 and iodosulfuron-methyl; compound 9 and iodosulfuron-methyl; compound 58 and iodosulfuron-methyl; compound 64 and iodosulfuron-methyl; compound 65 (and salts thereof) and iodosulfuron-methyl; compound 94 and iodosulfuron-methyl; compound 95 (and salts thereof) and iodosulfuron-methyl; compound 96 and iodosulfuron-methyl; compound 135 (and salts thereof) and iodosulfuron-methyl; compound 4 and isoproturon; compound 9 and isoproturon; compound 58 and isoproturon; compound 64 and isoproturon; compound 65 (and salts thereof) and isoproturon; compound 94 and isoproturon; compound 95 (and salts thereof) and isoproturon; compound 96 and isoproturon; compound 135 (and salts thereof) and isoproturon; compound 4 and ametryn; compound 9 and ametryn; compound 58 and ametryn; compound 64 and ametryn; compound 65 (and salts thereof) and ametryn; compound 94 and ametryn; compound 95 (and salts thereof) and ametryn; compound 96 and ametryn; compound 135 (and salts thereof) and ametryn; compound 4 and amitrole; compound 9 and amitrole; compound 58 and amitrole; compound 64 and amitrole; compound 65 (and salts thereof) and amitrole; compound 94 and amitrole; compound 95 (and salts thereof) and amitrole; compound 96 and amitrole; compound 135 (and salts thereof) and amitrole; compound 4 and paraquat dichloride; compound 9 and paraquat dichloride; compound 58 and paraquat dichloride; compound 64 and paraquat dichloride; compound 65 (and salts thereof) and paraquat dichloride; compound 94 and paraquat dichloride; compound 95 (and salts thereof) and paraquat dichloride; compound 96 and paraquat dichloride; compound 135 (and salts thereof) and paraquat dichloride; compound 4 and diquat dibromide; compound 9 and diquat dibromide; compound 58 and diquat dibromide; compound 64 and diquat dibromide; compound 65 (and salts thereof) and diquat dibromide; compound 94 and diquat dibromide; compound 95 (and salts thereof) and diquat dibromide; compound 96 and diquat dibromide; compound 135 (and salts thereof) and diquat dibromide; compound 4 and atrazine; compound 9 and atrazine; compound 58 and atrazine; compound 64 and atrazine; compound 65 (and salts thereof) and atrazine; compound 94 and atrazine; compound 95 (and salts thereof) and atrazine; compound 96 and atrazine; compound 135 (and salts thereof) and atrazine; compound 4 and metribuzin; compound 9 and metribuzin; compound 58 and metribuzin; compound 64 and metribuzin; compound 65 (and salts thereof) and metribuzin; compound 94 and metribuzin; compound 95 (and salts thereof) and metribuzin; compound 96 and metribuzin; compound 135 (and salts thereof) and metribuzin; compound 4 and acetochlor; compound 9 and acetochlor; compound 58 and acetochlor; compound 64 and acetochlor; compound 65 (and salts thereof)

and acetochlor; compound 94 and acetochlor; compound 95 (and salts thereof) and acetochlor; compound 96 and acetochlor; compound 135 (and salts thereof) and acetochlor; compound 4 and metolachlor; compound 9 and metolachlor; compound 58 and metolachlor; compound 64 and metolachlor; compound 65 (and salts thereof) and metolachlor; compound 94 and metolachlor; compound 95 (and salts thereof) and metolachlor; compound 96 and metolachlor; compound 135 (and salts thereof) and metolachlor; compound 4 and S-metolachlor; compound 9 and S-metolachlor; compound 58 and S-metolachlor; compound 64 and S-metolachlor; compound 65 (and salts thereof) and S-metolachlor; compound 94 and S-metolachlor; compound 95 (and salts thereof) and S-metolachlor; compound 96 and S-metolachlor; compound 135 (and salts thereof) and S-metolachlor; compound 4 and alachlor; compound 9 and alachlor; compound 58 and alachlor; compound 64 and alachlor; compound 65 (and salts thereof) and alachlor; compound 94 and alachlor; compound 95 (and salts thereof) and alachlor; compound 96 and alachlor; compound 135 (and salts thereof) and alachlor; compound 4 and pretilachlor; compound 9 and pretilachlor; compound 58 and pretilachlor; compound 64 and pretilachlor; compound 65 (and salts thereof) and pretilachlor; compound 94 and pretilachlor; compound 95 (and salts thereof) and pretilachlor; compound 96 and pretilachlor; compound 135 (and salts thereof) and pretilachlor; compound 4 and sethoxydim; compound 9 and sethoxydim; compound 58 and sethoxydim; compound 64 and sethoxydim; compound 65 (and salts thereof) and sethoxydim; compound 94 and sethoxydim; compound 95 (and salts thereof) and sethoxydim; compound 96 and sethoxydim; compound 135 (and salts thereof) and sethoxydim; compound 4 and tralkoxydim; compound 9 and tralkoxydim; compound 58 and tralkoxydim; compound 64 and tralkoxydim; compound 65 (and salts thereof) and tralkoxydim; compound 94 and tralkoxydim; compound 95 (and salts thereof) and tralkoxydim; compound 96 and tralkoxydim; compound 135 (and salts thereof) and tralkoxydim; compound 4 and clethodim; compound 9 and clethodim; compound 58 and clethodim; compound 64 and clethodim; compound 65 (and salts thereof) and clethodim; compound 94 and clethodim; compound 95 (and salts thereof) and clethodim; compound 96 and clethodim; compound 135 (and salts thereof) and clethodim; compound 4 and cyhalofop-butyl; compound 9 and cyhalofop-butyl; compound 58 and cyhalofop-butyl; compound 64 and cyhalofop-butyl; compound 65 (and salts thereof) and cyhalofop-butyl; compound 94 and cyhalofop-butyl; compound 95 (and salts thereof) and cyhalofop-butyl; compound 96 and cyhalofop-butyl; compound 135 (and salts thereof) and cyhalofop-butyl; compound 4 and quizalofop-ethyl; compound 9 and quizalofop-ethyl; compound 58 and quizalofop-ethyl; compound 64 and quizalofop-ethyl; compound 65 (and salts thereof) and quizalofop-ethyl; compound 94 and quizalofop-ethyl; compound 95 (and salts thereof) and quizalofop-ethyl; compound 96 and quizalofop-ethyl; compound 135 (and salts thereof) and quizalofop-ethyl; compound 4 and diclofop-methyl; compound 9 and diclofop-methyl;

compound 58 and diclofop-methyl; compound 64 and diclofop-methyl; compound 65 (and salts thereof) and diclofop-methyl; compound 94 and diclofop-methyl; compound 95 (and salts thereof) and diclofop-methyl; compound 96 and diclofop-methyl; compound 135 (and salts thereof) and diclofop-methyl; compound 4 and clodinafop-propargyl; compound 9 and clodinafop-propargyl; compound 58 and clodinafop-propargyl; compound 64 and clodinafop-propargyl; compound 65 (and salts thereof) and clodinafop-propargyl; compound 94 and clodinafop-propargyl; compound 95 (and salts thereof) and clodinafop-propargyl; compound 96 and clodinafop-propargyl; compound 135 (and salts thereof) and clodinafop-propargyl; compound 4 and fenoxaprop-ethyl; compound 9 and fenoxaprop-ethyl; compound 58 and fenoxaprop-ethyl; compound 64 and fenoxaprop-ethyl; compound 65 (and salts thereof) and fenoxaprop-ethyl; compound 94 and fenoxaprop-ethyl; compound 95 (and salts thereof) and fenoxaprop-ethyl; compound 96 and fenoxaprop-ethyl; compound 135 (and salts thereof) and fenoxaprop-ethyl; compound 4 and dimethenamid; compound 9 and dimethenamid; compound 58 and dimethenamid; compound 64 and dimethenamid; compound 65 (and salts thereof) and dimethenamid; compound 94 and dimethenamid; compound 95 (and salts thereof) and dimethenamid; compound 96 and dimethenamid; compound 135 (and salts thereof) and dimethenamid; compound 4 and flufenacet; compound 9 and flufenacet; compound 58 and flufenacet; compound 64 and flufenacet; compound 65 (and salts thereof) and flufenacet; compound 94 and flufenacet; compound 95 (and salts thereof) and flufenacet; compound 96 and flufenacet; compound 135 (and salts thereof) and flufenacet; compound 4 and picloram; compound 9 and picloram; compound 58 and picloram; compound 64 and picloram; compound 65 (and salts thereof) and picloram; compound 94 and picloram; compound 95 (and salts thereof) and picloram; compound 96 and picloram; compound 135 (and salts thereof) and picloram; compound 4 and prodiamine; compound 9 and prodiamine; compound 58 and prodiamine; compound 64 and prodiamine; compound 65 (and salts thereof) and prodiamine; compound 94 and prodiamine; compound 95 (and salts thereof) and prodiamine; compound 96 and prodiamine; compound 135 (and salts thereof) and prodiamine; compound 4 and fosamine-ammonium; compound 9 and fosamine-ammonium; compound 58 and fosamine-ammonium; compound 64 and fosamine-ammonium; compound 65 (and salts thereof) and fosamine-ammonium; compound 94 and fosamine-ammonium; compound 95 (and salts thereof) and fosamine-ammonium; compound 96 and fosamine-ammonium; compound 135 (and salts thereof) and fosamine-ammonium; compound 4 and 2,4-D; compound 9 and 2,4-D; compound 58 and 2,4-D; compound 64 and 2,4-D; compound 65 (and salts thereof) and 2,4-D; compound 94 and 2,4-D; compound 95 (and salts thereof) and 2,4-D; compound 96 and 2,4-D; compound 135 (and salts thereof) and 2,4-D; compound 4 and 2,4-DB; compound 9 and 2,4-DB; compound 58 and 2,4-DB; compound 64 and 2,4-DB; compound 65 (and salts thereof) and 2,4-DB; compound 94 and 2,4-DB; compound 95 (and salts thereof) and 2,4-DB; compound 96 and 2,4-DB; compound

135 (and salts thereof) and 2,4-DB; compound 4 and dicamba; compound 9 and dicamba; compound 58 and dicamba; compound 64 and dicamba; compound 65 (and salts thereof) and dicamba; compound 94 and dicamba; compound 95 (and salts thereof) and dicamba; compound 96 and dicamba; compound 135 (and salts thereof) and dicamba; compound 4 and penoxsulam; compound 9 and penoxsulam; compound 58 and penoxsulam; compound 64 and penoxsulam; compound 65 (and salts thereof) and penoxsulam; compound 94 and penoxsulam; compound 95 (and salts thereof) and penoxsulam; compound 96 and penoxsulam; compound 135 (and salts thereof) and penoxsulam; compound 4 and flumetsulam; compound 9 and flumetsulam; compound 58 and flumetsulam; compound 64 and flumetsulam; compound 65 (and salts thereof) and flumetsulam; compound 94 and flumetsulam; compound 95 (and salts thereof) and flumetsulam; compound 96 and flumetsulam; compound 135 (and salts thereof) and flumetsulam; compound 4 and naptalam; compound 9 and naptalam; compound 58 and naptalam; compound 64 and naptalam; compound 65 (and salts thereof) and naptalam; compound 94 and naptalam; compound 95 (and salts thereof) and naptalam; compound 96 and naptalam; compound 135 (and salts thereof) and naptalam; compound 4 and pendimethalin; compound 9 and pendimethalin; compound 58 and pendimethalin; compound 64 and pendimethalin; compound 65 (and salts thereof) and pendimethalin; compound 94 and pendimethalin; compound 95 (and salts thereof) and pendimethalin; compound 96 and pendimethalin; compound 135 (and salts thereof) and pendimethalin; compound 4 and oryzalin; compound 9 and oryzalin; compound 58 and oryzalin; compound 64 and oryzalin; compound 65 (and salts thereof) and oryzalin; compound 94 and oryzalin; compound 95 (and salts thereof) and oryzalin; compound 96 and oryzalin; compound 135 (and salts thereof) and oryzalin; compound 4 and MCPA (and salts and (thio)esters thereof); compound 9 and MCPA (and salts and (thio)esters thereof); compound 58 and MCPA (and salts and (thio)esters thereof); compound 64 and MCPA (and salts and (thio)esters thereof); compound 65 (and salts thereof) and MCPA (and salts and (thio)esters thereof); compound 94 and MCPA (and salts and (thio)esters thereof); compound 95 (and salts thereof) and MCPA (and salts and (thio)esters thereof); compound 96 and MCPA (and salts and (thio)esters thereof); compound 135 (and salts thereof) and MCPA (and salts and (thio)esters thereof); compound 4 and mecoprop; compound 9 and mecoprop; compound 58 and mecoprop; compound 64 and mecoprop; compound 65 (and salts thereof) and mecoprop; compound 94 and mecoprop; compound 95 (and salts thereof) and mecoprop; compound 96 and mecoprop; compound 135 (and salts thereof) and mecoprop; compound 4 and clopyralid; compound 9 and clopyralid; compound 58 and clopyralid; compound 64 and clopyralid; compound 65 (and salts thereof) and clopyralid; compound 94 and clopyralid; compound 95 (and salts thereof) and clopyralid; compound 96 and clopyralid; compound 135 (and salts thereof) and clopyralid; compound 4 and aminopyralid; compound 9 and aminopyralid; compound 58 and

aminopyralid; compound 64 and aminopyralid; compound 65 (and salts thereof) and aminopyralid; compound 94 and aminopyralid; compound 95 (and salts thereof) and aminopyralid; compound 96 and aminopyralid; compound 135 (and salts thereof) and aminopyralid; compound 4 and triclopyr; compound 9 and triclopyr; compound 58 and triclopyr; compound 64 and triclopyr; compound 65 (and salts thereof) and triclopyr; compound 94 and triclopyr; compound 95 (and salts thereof) and triclopyr; compound 96 and triclopyr; compound 135 (and salts thereof) and triclopyr; compound 4 and fluroxypyr; compound 9 and fluroxypyr; compound 58 and fluroxypyr; compound 64 and fluroxypyr; compound 65 (and salts thereof) and fluroxypyr; compound 94 and fluroxypyr; compound 95 (and salts thereof) and fluroxypyr; compound 96 and fluroxypyr; compound 135 (and salts thereof) and fluroxypyr; compound 4 and diflufenzopyr; compound 9 and diflufenzopyr; compound 58 and diflufenzopyr; compound 64 and diflufenzopyr; compound 65 (and salts thereof) and diflufenzopyr; compound 94 and diflufenzopyr; compound 95 (and salts thereof) and diflufenzopyr; compound 96 and diflufenzopyr; compound 135 (and salts thereof) and diflufenzopyr; compound 4 and imazapyr; compound 9 and imazapyr; compound 58 and imazapyr; compound 64 and imazapyr; compound 65 (and salts thereof) and imazapyr; compound 94 and imazapyr; compound 95 (and salts thereof) and imazapyr; compound 96 and imazapyr; compound 135 (and salts thereof) and imazapyr; compound 4 and imazethapyr; compound 9 and imazethapyr; compound 58 and imazethapyr; compound 64 and imazethapyr; compound 65 (and salts thereof) and imazethapyr; compound 94 and imazethapyr; compound 95 (and salts thereof) and imazethapyr; compound 96 and imazethapyr; compound 135 (and salts thereof) and imazethapyr; compound 4 and imazamox; compound 9 and imazamox; compound 58 and imazamox; compound 64 and imazamox; compound 65 (and salts thereof) and imazamox; compound 94 and imazamox; compound 95 (and salts thereof) and imazamox; compound 96 and imazamox; compound 135 (and salts thereof) and imazamox; compound 4 and picolinafen; compound 9 and picolinafen; compound 58 and picolinafen; compound 64 and picolinafen; compound 65 (and salts thereof) and picolinafen; compound 94 and picolinafen; compound 95 (and salts thereof) and picolinafen; compound 96 and picolinafen; compound 135 (and salts thereof) and picolinafen; compound 4 and oxyfluorfen; compound 9 and oxyfluorfen; compound 58 and oxyfluorfen; compound 64 and oxyfluorfen; compound 65 (and salts thereof) and oxyfluorfen; compound 94 and oxyfluorfen; compound 95 (and salts thereof) and oxyfluorfen; compound 96 and oxyfluorfen; compound 135 (and salts thereof) and oxyfluorfen; compound 4 and oxadiazon; compound 9 and oxadiazon; compound 58 and oxadiazon; compound 64 and oxadiazon; compound 65 (and salts thereof) and oxadiazon; compound 94 and oxadiazon; compound 95 (and salts thereof) and oxadiazon; compound 96 and oxadiazon; compound 135 (and salts thereof) and oxadiazon; compound 4 and carfentrazone-ethyl; compound 9 and carfentrazone-ethyl; compound 58 and carfentrazone-

ethyl; compound 64 and carfentrazone-ethyl; compound 65 (and salts thereof) and carfentrazone-ethyl; compound 94 and carfentrazone-ethyl; compound 95 (and salts thereof) and carfentrazone-ethyl; compound 96 and carfentrazone-ethyl; compound 135 (and salts thereof) and carfentrazone-ethyl; compound 4 and sulfentrazone; compound 9 and sulfentrazone; compound 58 and sulfentrazone; compound 64 and sulfentrazone; compound 65 (and salts thereof) and sulfentrazone; compound 94 and sulfentrazone; compound 95 (and salts thereof) and sulfentrazone; compound 96 and sulfentrazone; compound 135 (and salts thereof) and sulfentrazone; compound 4 and flumioxazin; compound 9 and flumioxazin; compound 58 and flumioxazin; compound 64 and flumioxazin; compound 65 (and salts thereof) and flumioxazin; compound 94 and flumioxazin; compound 95 (and salts thereof) and flumioxazin; compound 96 and flumioxazin; compound 135 (and salts thereof) and flumioxazin; compound 4 and diflufenican; compound 9 and diflufenican; compound 58 and diflufenican; compound 64 and diflufenican; compound 65 (and salts thereof) and diflufenican; compound 94 and diflufenican; compound 95 (and salts thereof) and diflufenican; compound 96 and diflufenican; compound 135 (and salts thereof) and diflufenican; compound 4 and bromoxynil; compound 9 and bromoxynil; compound 58 and bromoxynil; compound 64 and bromoxynil; compound 65 (and salts thereof) and bromoxynil; compound 94 and bromoxynil; compound 95 (and salts thereof) and bromoxynil; compound 96 and bromoxynil; compound 135 (and salts thereof) and bromoxynil; compound 4 and propanil; compound 9 and propanil; compound 58 and propanil; compound 64 and propanil; compound 65 (and salts thereof) and propanil; compound 94 and propanil; compound 95 (and salts thereof) and propanil; compound 96 and propanil; compound 135 (and salts thereof) and propanil; compound 4 and thiobencarb; compound 9 and thiobencarb; compound 58 and thiobencarb; compound 64 and thiobencarb; compound 65 (and salts thereof) and thiobencarb; compound 94 and thiobencarb; compound 95 (and salts thereof) and thiobencarb; compound 96 and thiobencarb; compound 135 (and salts thereof) and thiobencarb; compound 4 and fluridone; compound 9 and fluridone; compound 58 and fluridone; compound 64 and fluridone; compound 65 (and salts thereof) and fluridone; compound 94 and fluridone; compound 95 (and salts thereof) and fluridone; compound 96 and fluridone; compound 135 (and salts thereof) and fluridone; compound 4 and mesotrione; compound 9 and mesotrione; compound 58 and mesotrione; compound 64 and mesotrione; compound 65 (and salts thereof) and mesotrione; compound 94 and mesotrione; compound 95 (and salts thereof) and mesotrione; compound 96 and mesotrione; compound 135 (and salts thereof) and mesotrione; compound 4 and sulcotrione; compound 9 and sulcotrione; compound 58 and sulcotrione; compound 64 and sulcotrione; compound 65 (and salts thereof) and sulcotrione; compound 94 and sulcotrione; compound 95 (and salts thereof) and sulcotrione; compound 96 and sulcotrione; compound 135 (and salts thereof) and

sulcotrione; compound 4 and isoxaflutole; compound 9 and isoxaflutole; compound 58 and isoxaflutole; compound 64 and isoxaflutole; compound 65 (and salts thereof) and isoxaflutole; compound 94 and isoxaflutole; compound 95 (and salts thereof) and isoxaflutole; compound 96 and isoxaflutole; compound 135 (and salts thereof) and isoxaflutole; compound 4 and isoxaben; compound 9 and isoxaben; compound 58 and isoxaben; compound 64 and isoxaben; compound 65 (and salts thereof) and isoxaben; compound 94 and isoxaben; compound 95 (and salts thereof) and isoxaben; compound 96 and isoxaben; compound 135 (and salts thereof) and isoxaben; compound 4 and clomazone; compound 9 and clomazone; compound 58 and clomazone; compound 64 and clomazone; compound 65 (and salts thereof) and clomazone; compound 94 and clomazone; compound 95 (and salts thereof) and clomazone; compound 96 and clomazone; compound 135 (and salts thereof) and clomazone; compound 4 and beflubutamid; compound 9 and beflubutamid; compound 58 and beflubutamid; compound 64 and beflubutamid; compound 65 (and salts thereof) and beflubutamid; compound 94 and beflubutamid; compound 95 (and salts thereof) and beflubutamid; compound 96 and beflubutamid; compound 135 (and salts thereof) and beflubutamid; compound 4 and benfuresate; compound 9 and benfuresate; compound 58 and benfuresate; compound 64 and benfuresate; compound 65 (and salts thereof) and benfuresate; compound 94 and benfuresate; compound 95 (and salts thereof) and benfuresate; compound 96 and benfuresate; compound 135 (and salts thereof) and benfuresate; compound 4 and bentazone; compound 9 and bentazone; compound 58 and bentazone; compound 64 and bentazone; compound 65 (and salts thereof) and bentazone; compound 94 and bentazone; compound 95 (and salts thereof) and bentazone; compound 96 and bentazone; compound 135 (and salts thereof) and bentazone; compound 4 and benzobicyclon; compound 9 and benzobicyclon; compound 58 and benzobicyclon; compound 64 and benzobicyclon; compound 65 (and salts thereof) and benzobicyclon; compound 94 and benzobicyclon; compound 95 (and salts thereof) and benzobicyclon; compound 96 and benzobicyclon; compound 135 (and salts thereof) and benzobicyclon; compound 4 and benzofenap; compound 9 and benzofenap; compound 58 and benzofenap; compound 64 and benzofenap; compound 65 (and salts thereof) and benzofenap; compound 94 and benzofenap; compound 95 (and salts thereof) and benzofenap; compound 96 and benzofenap; compound 135 (and salts thereof) and benzofenap; compound 4 and bromobutide; compound 9 and bromobutide; compound 58 and bromobutide; compound 64 and bromobutide; compound 65 (and salts thereof) and bromobutide; compound 94 and bromobutide; compound 95 (and salts thereof) and bromobutide; compound 96 and bromobutide; compound 135 (and salts thereof) and bromobutide; compound 4 and butachlor; compound 9 and butachlor; compound 58 and butachlor; compound 64 and butachlor; compound 65 (and salts thereof) and butachlor; compound 94 and butachlor; compound 95 (and salts thereof) and butachlor; compound 96 and butachlor; compound 135

(and salts thereof) and butachlor; compound 4 and cafenstrole; compound 9 and cafenstrole; compound 58 and cafenstrole; compound 64 and cafenstrole; compound 65 (and salts thereof) and cafenstrole; compound 94 and cafenstrole; compound 95 (and salts thereof) and cafenstrole; compound 96 and cafenstrole; compound 135 (and salts thereof) and cafenstrole; compound 4 and clomeprop; compound 9 and clomeprop; compound 58 and clomeprop; compound 64 and clomeprop; compound 65 (and salts thereof) and clomeprop; compound 94 and clomeprop; compound 95 (and salts thereof) and clomeprop; compound 96 and clomeprop; compound 135 (and salts thereof) and clomeprop; compound 4 and dimepiperate; compound 9 and dimepiperate; compound 58 and dimepiperate; compound 64 and dimepiperate; compound 65 (and salts thereof) and dimepiperate; compound 94 and dimepiperate; compound 95 (and salts thereof) and dimepiperate; compound 96 and dimepiperate; compound 135 (and salts thereof) and dimepiperate; compound 4 and dimethametryn; compound 9 and dimethametryn; compound 58 and dimethametryn; compound 64 and dimethametryn; compound 65 (and salts thereof) and dimethametryn; compound 94 and dimethametryn; compound 95 (and salts thereof) and dimethametryn; compound 96 and dimethametryn; compound 135 (and salts thereof) and dimethametryn; compound 4 and diamuron; compound 9 and diamuron; compound 58 and diamuron; compound 64 and diamuron; compound 65 (and salts thereof) and diamuron; compound 94 and diamuron; compound 95 (and salts thereof) and diamuron; compound 96 and diamuron; compound 135 (and salts thereof) and diamuron; compound 4 and esprocarb; compound 9 and esprocarb; compound 58 and esprocarb; compound 64 and esprocarb; compound 65 (and salts thereof) and esprocarb; compound 94 and esprocarb; compound 95 (and salts thereof) and esprocarb; compound 96 and esprocarb; compound 135 (and salts thereof) and esprocarb; compound 4 and etobenzanide; compound 9 and etobenzanide; compound 58 and etobenzanide; compound 64 and etobenzanide; compound 65 (and salts thereof) and etobenzanide; compound 94 and etobenzanide; compound 95 (and salts thereof) and etobenzanide; compound 96 and etobenzanide; compound 135 (and salts thereof) and etobenzanide; compound 4 and fentrazamid; compound 9 and fentrazamid; compound 58 and fentrazamid; compound 64 and fentrazamid; compound 65 (and salts thereof) and fentrazamid; compound 94 and fentrazamid; compound 95 (and salts thereof) and fentrazamid; compound 96 and fentrazamid; compound 135 (and salts thereof) and fentrazamid; compound 4 and indanofan; compound 9 and indanofan; compound 58 and indanofan; compound 64 and indanofan; compound 65 (and salts thereof) and indanofan; compound 94 and indanofan; compound 95 (and salts thereof) and indanofan; compound 96 and indanofan; compound 135 (and salts thereof) and indanofan; compound 4 and cumylron; compound 9 and cumylron; compound 58 and cumylron; compound 64 and cumylron; compound 65 (and salts thereof) and cumylron; compound 94 and cumylron; compound 95 (and salts thereof) and cumylron; compound 96 and cumylron; compound 135 (and salts

thereof) and cumylron; compound 4 and menfenacet; compound 9 and menfenacet; compound 58 and menfenacet; compound 64 and menfenacet; compound 65 (and salts thereof) and menfenacet; compound 94 and menfenacet; compound 95 (and salts thereof) and menfenacet; compound 96 and menfenacet; compound 135 (and salts thereof) and menfenacet; compound 4 and oxaziclomefone; compound 9 and oxaziclomefone; compound 58 and oxaziclomefone; compound 64 and oxaziclomefone; compound 65 (and salts thereof) and oxaziclomefone; compound 94 and oxaziclomefone; compound 95 (and salts thereof) and oxaziclomefone; compound 96 and oxaziclomefone; compound 135 (and salts thereof) and oxaziclomefone; compound 4 and oxadiargyl; compound 9 and oxadiargyl; compound 58 and oxadiargyl; compound 64 and oxadiargyl; compound 65 (and salts thereof) and oxadiargyl; compound 94 and oxadiargyl; compound 95 (and salts thereof) and oxadiargyl; compound 96 and oxadiargyl; compound 135 (and salts thereof) and oxadiargyl; compound 4 and pentoxazone; compound 9 and pentoxazone; compound 58 and pentoxazone; compound 64 and pentoxazone; compound 65 (and salts thereof) and pentoxazone; compound 94 and pentoxazone; compound 95 (and salts thereof) and pentoxazone; compound 96 and pentoxazone; compound 135 (and salts thereof) and pentoxazone; compound 4 and pyraclonil; compound 9 and pyraclonil; compound 58 and pyraclonil; compound 64 and pyraclonil; compound 65 (and salts thereof) and pyraclonil; compound 94 and pyraclonil; compound 95 (and salts thereof) and pyraclonil; compound 96 and pyraclonil; compound 135 (and salts thereof) and pyraclonil; compound 4 and pyrazolate; compound 9 and pyrazolate; compound 58 and pyrazolate; compound 64 and pyrazolate; compound 65 (and salts thereof) and pyrazolate; compound 94 and pyrazolate; compound 95 (and salts thereof) and pyrazolate; compound 96 and pyrazolate; compound 135 (and salts thereof) and pyrazolate; compound 4 and pyributicarb; compound 9 and pyributicarb; compound 58 and pyributicarb; compound 64 and pyributicarb; compound 65 (and salts thereof) and pyributicarb; compound 94 and pyributicarb; compound 95 (and salts thereof) and pyributicarb; compound 96 and pyributicarb; compound 135 (and salts thereof) and pyributicarb; compound 4 and pyriftalid; compound 9 and pyriftalid; compound 58 and pyriftalid; compound 64 and pyriftalid; compound 65 (and salts thereof) and pyriftalid; compound 94 and pyriftalid; compound 95 (and salts thereof) and pyriftalid; compound 96 and pyriftalid; compound 135 (and salts thereof) and pyriftalid; compound 4 and pyriminobac-methyl; compound 9 and pyriminobac-methyl; compound 58 and pyriminobac-methyl; compound 64 and pyriminobac-methyl; compound 65 (and salts thereof) and pyriminobac-methyl; compound 94 and pyriminobac-methyl; compound 95 (and salts thereof) and pyriminobac-methyl; compound 96 and pyriminobac-methyl; compound 135 (and salts thereof) and pyriminobac-methyl; compound 4 and thenylchlor; compound 9 and thenylchlor; compound 58 and thenylchlor; compound 64 and thenylchlor; compound 65 (and salts thereof) and thenylchlor; compound 94 and thenylchlor; compound 95 (and salts

thereof) and thenylchlor; compound 96 and thenylchlor; compound 135 (and salts thereof) and thenylchlor; compound 4 and bispyribac-sodium; compound 9 and bispyribac-sodium; compound 58 and bispyribac-sodium; compound 64 and bispyribac-sodium; compound 65 (and salts thereof) and bispyribac-sodium; compound 94 and bispyribac-sodium; compound 95 (and salts thereof) and bispyribac-sodium; compound 96 and bispyribac-sodium; compound 135 (and salts thereof) and bispyribac-sodium; compound 4 and clefoxydim; compound 9 and clefoxydim; compound 58 and clefoxydim; compound 64 and clefoxydim; compound 65 (and salts thereof) and clefoxydim; compound 94 and clefoxydim; compound 95 (and salts thereof) and clefoxydim; compound 96 and clefoxydim; compound 135 (and salts thereof) and clefoxydim; compound 4 and cinosulfuron; compound 9 and cinosulfuron; compound 58 and cinosulfuron; compound 64 and cinosulfuron; compound 65 (and salts thereof) and cinosulfuron; compound 94 and cinosulfuron; compound 95 (and salts thereof) and cinosulfuron; compound 96 and cinosulfuron; compound 135 (and salts thereof) and cinosulfuron; compound 4 and cyclosulfamuron; compound 9 and cyclosulfamuron; compound 58 and cyclosulfamuron; compound 64 and cyclosulfamuron; compound 65 (and salts thereof) and cyclosulfamuron; compound 94 and cyclosulfamuron; compound 95 (and salts thereof) and cyclosulfamuron; compound 96 and cyclosulfamuron; compound 135 (and salts thereof) and cyclosulfamuron; compound 4 and ethoxysulfuron; compound 9 and ethoxysulfuron; compound 58 and ethoxysulfuron; compound 64 and ethoxysulfuron; compound 65 (and salts thereof) and ethoxysulfuron; compound 94 and ethoxysulfuron; compound 95 (and salts thereof) and ethoxysulfuron; compound 96 and ethoxysulfuron; compound 135 (and salts thereof) and ethoxysulfuron; compound 4 and epoprodan; compound 9 and epoprodan; compound 58 and epoprodan; compound 64 and epoprodan; compound 65 (and salts thereof) and epoprodan; compound 94 and epoprodan; compound 95 (and salts thereof) and epoprodan; compound 96 and epoprodan; compound 135 (and salts thereof) and epoprodan; compound 4 and flucetosulfuron; compound 9 and flucetosulfuron; compound 58 and flucetosulfuron; compound 64 and flucetosulfuron; compound 65 (and salts thereof) and flucetosulfuron; compound 94 and flucetosulfuron; compound 95 (and salts thereof) and flucetosulfuron; compound 96 and flucetosulfuron; compound 135 (and salts thereof) and flucetosulfuron; compound 4 and imazosulfuron; compound 9 and imazosulfuron; compound 58 and imazosulfuron; compound 64 and imazosulfuron; compound 65 (and salts thereof) and imazosulfuron; compound 94 and imazosulfuron; compound 95 (and salts thereof) and imazosulfuron; compound 96 and imazosulfuron; compound 135 (and salts thereof) and imazosulfuron; compound 4 and metamifop; compound 9 and metamifop; compound 58 and metamifop; compound 64 and metamifop; compound 65 (and salts thereof) and metamifop; compound 94 and metamifop; compound 95 (and salts thereof) and metamifop; compound 96 and metamifop; compound 135 (and salts thereof) and metamifop; compound 4 and pyrazosulfuron-ethyl; compound 9 and

pyrazosulfuron-ethyl; compound 58 and pyrazosulfuron-ethyl; compound 64 and pyrazosulfuron-ethyl; compound 65 (and salts thereof) and pyrazosulfuron-ethyl; compound 94 and pyrazosulfuron-ethyl; compound 95 (and salts thereof) and pyrazosulfuron-ethyl; compound 96 and pyrazosulfuron-ethyl; compound 135 (and salts thereof) and pyrazosulfuron-ethyl; compound 4 and quinclorac; compound 9 and quinclorac; compound 58 and quinclorac; compound 64 and quinclorac; compound 65 (and salts thereof) and quinclorac; compound 94 and quinclorac; compound 95 (and salts thereof) and quinclorac; compound 96 and quinclorac; compound 135 (and salts thereof) and quinclorac; compound 4 and flucarbazone-sodium; compound 9 and flucarbazone-sodium; compound 58 and flucarbazone-sodium; compound 64 and flucarbazone-sodium; compound 65 (and salts thereof) and flucarbazone-sodium; compound 94 and flucarbazone-sodium; compound 95 (and salts thereof) and flucarbazone-sodium; compound 96 and flucarbazone-sodium; compound 135 (and salts thereof) and flucarbazone-sodium; compound 4 and propoxycarbazone-sodium; compound 9 and propoxycarbazone-sodium; compound 58 and propoxycarbazone-sodium; compound 64 and propoxycarbazone-sodium; compound 65 (and salts thereof) and propoxycarbazone-sodium; compound 94 and propoxycarbazone-sodium; compound 95 (and salts thereof) and propoxycarbazone-sodium; compound 96 and propoxycarbazone-sodium; compound 135 (and salts thereof) and propoxycarbazone-sodium; compound 4 and amicarbazone; compound 9 and amicarbazone; compound 58 and amicarbazone; compound 64 and amicarbazone; compound 65 (and salts thereof) and amicarbazone; compound 94 and amicarbazone; compound 95 (and salts thereof) and amicarbazone; compound 96 and amicarbazone; compound 135 (and salts thereof) and amicarbazone; compound 4 and florasulam; compound 9 and florasulam; compound 58 and florasulam; compound 64 and florasulam; compound 65 (and salts thereof) and florasulam; compound 94 and florasulam; compound 95 (and salts thereof) and florasulam; compound 96 and florasulam; compound 135 (and salts thereof) and florasulam; compound 4 and triasulfuron; compound 9 and triasulfuron; compound 58 and triasulfuron; compound 64 and triasulfuron; compound 65 (and salts thereof) and triasulfuron; compound 94 and triasulfuron; compound 95 (and salts thereof) and triasulfuron; compound 96 and triasulfuron; compound 135 (and salts thereof) and triasulfuron; compound 4 and triaziflam; compound 9 and triaziflam; compound 58 and triaziflam; compound 64 and triaziflam; compound 65 (and salts thereof) and triaziflam; compound 94 and triaziflam; compound 95 (and salts thereof) and triaziflam; compound 96 and triaziflam; compound 135 (and salts thereof) and triaziflam; compound 4 and pinoxaden; compound 9 and pinoxaden; compound 58 and pinoxaden; compound 64 and pinoxaden; compound 65 (and salts thereof) and pinoxaden; compound 94 and pinoxaden; compound 95 (and salts thereof) and pinoxaden; compound 96 and pinoxaden; compound 135 (and salts thereof) and pinoxaden;

compound 4 and tritosulfuron; compound 9 and tritosulfuron; compound 58 and tritosulfuron; compound 64 and tritosulfuron; compound 65 (and salts thereof) and tritosulfuron; compound 94 and tritosulfuron; compound 95 (and salts thereof) and tritosulfuron; compound 96 and tritosulfuron; compound 135 (and salts thereof) and tritosulfuron; compound 4 and amidosulfuron; compound 9 and amidosulfuron; compound 58 and amidosulfuron; compound 64 and amidosulfuron; compound 65 (and salts thereof) and amidosulfuron; compound 94 and amidosulfuron; compound 95 (and salts thereof) and amidosulfuron; compound 96 and amidosulfuron; compound 135 (and salts thereof) and amidosulfuron; compound 4 and metosulam; compound 9 and metosulam; compound 58 and metosulam; compound 64 and metosulam; compound 65 (and salts thereof) and metosulam; compound 94 and metosulam; compound 95 (and salts thereof) and metosulam; compound 96 and metosulam; compound 135 (and salts thereof) and metosulam; compound 4 and sulfosulfuron; compound 9 and sulfosulfuron; compound 58 and sulfosulfuron; compound 64 and sulfosulfuron; compound 65 (and salts thereof) and sulfosulfuron; compound 94 and sulfosulfuron; compound 95 (and salts thereof) and sulfosulfuron; compound 96 and sulfosulfuron; compound 135 (and salts thereof) and sulfosulfuron; compound 4 and pyraflufen-ethyl; compound 9 and pyraflufen-ethyl; compound 58 and pyraflufen-ethyl; compound 64 and pyraflufen-ethyl; compound 65 (and salts thereof) and pyraflufen-ethyl; compound 94 and pyraflufen-ethyl; compound 95 (and salts thereof) and pyraflufen-ethyl; compound 96 and pyraflufen-ethyl; compound 135 (and salts thereof) and pyraflufen-ethyl; compound 4 and HOK-201; compound 9 and HOK-201; compound 58 and HOK-201; compound 64 and HOK-201; compound 65 (and salts thereof) and HOK-201; compound 94 and HOK-201; compound 95 (and salts thereof) and HOK-201; compound 96 and HOK-201; compound 135 (and salts thereof) and HOK-201; compound 4 and KUH-021; compound 9 and KUH-021; compound 58 and KUH-021; compound 64 and KUH-021; compound 65 (and salts thereof) and KUH-021; compound 94 and KUH-021; compound 95 (and salts thereof) and KUH-021; compound 96 and KUH-021; compound 135 (and salts thereof) and KUH-021; compound 4 and CUH-35; compound 9 and CUH-35; compound 58 and CUH-35; compound 64 and CUH-35; compound 65 (and salts thereof) and CUH-35; compound 94 and CUH-35; compound 95 (and salts thereof) and CUH-35; compound 96 and CUH-35; compound 135 (and salts thereof) and CUH-35. The proportions of the compounds of the invention with other herbicidal active ingredients in herbicidal compositions are generally in the ratio of 100:1 to 1:100, more commonly 10:1 to 1:10 and most commonly 5:1 to 1:5 by weight. The optimum ratios can be easily determined by those skilled in the art based on the weed control spectrum desired.

Particularly noteworthy because of greater than additive (i.e. synergistic) efficacy on certain weeds are mixtures of compounds of the invention with auxin transport inhibitors (phytotropins), an example being the combination of compound 1 (ethyl 6-amino-5-bromo-

2-cyclopropyl-4-pyrimidinecarboxylate) with diflufenzopyr. Auxin transport inhibitors are chemical substances that inhibit auxin transport in plants, such as by binding with an auxin-carrier protein. Other examples of auxin transport inhibitors include naptalam (also known as *N*-(1-naphthyl)phthalamic acid and 2-[(1-naphthalenylamino)carbonyl]benzoic acid), 9-hydroxyfluorene-9-carboxylic acid and 2,3,5-triiodobenzoic acid. Therefore an aspect of the present invention relates to a herbicidal mixture comprising synergistically effective amounts of a compound of Claim 1 and an auxin transport inhibitor. Synergistically effective amounts of auxin transport inhibitors with the compounds of the invention can be easily determined.

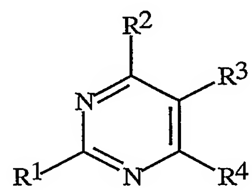
Compounds of this invention can also be used in combination with herbicide safeners such as benoxacor, BCS (1-bromo-4-[(chloromethyl)sulfonyl]benzene), cloquintocet-mexyl, cyometrinil, dichlormid, 2-(dichloromethyl)-2-methyl-1,3-dioxolane (MG 191), fenchlorazole-ethyl, fenclorim, flurazole, fluxofenim, furilazole, isoxadifen-ethyl, mefenpyr-ethyl, methoxyphenone ((4-methoxy-3-methylphenyl)(3-methylphenyl)methanone), naphthalic anhydride (1,8-naphthalic anhydride) and oxabetrinil to increase safety to certain crops. Antidotally effective amounts of the herbicide safeners can be applied at the same time as the compounds of this invention, or applied as seed treatments. Therefore an aspect of the present invention relates to a herbicidal mixture comprising a compound of this invention and an antidotally effective amount of a herbicide safener. Seed treatment is particularly useful for selective weed control, because it physically restricts antidoting to the crop plants. Therefore a particularly useful embodiment of the present invention is a method for selectively controlling the growth of undesired vegetation in a crop comprising contacting the locus of the crop with a herbicidally effective amount of a compound of this invention wherein seed from which the crop is grown is treated with an antidotally effective amount of safener. Antidotally effective amounts of safeners can be easily determined by one skilled in the art through simple experimentation.

Compounds of this invention can also be used in combination with plant growth regulators such as aviglycine, *N*-(phenylmethyl)-1*H*-purin-6-amine, epocholeone, gibberellic acid, gibberellin A_4 and A_7, harpin protein, mepiquat chloride, prohexadione calcium, prohydrojasmon, sodium nitrophenolate and trinexapac-methyl, and plant growth modifying organisms such as *Bacillus cereus* strain BP01.

The following Tests demonstrate the control efficacy of the compounds of this invention against specific weeds. The weed control afforded by the compounds is not limited, however, to these species. See Index Tables A–D for compound descriptions. The following abbreviations are used in the Index Tables which follow: *t* means tertiary, *s* means secondary, *n* means normal, *i* means iso, *c* means cyclo, Me means methyl, Et means ethyl, Pr means propyl, *i*-Pr means isopropyl, Bu means butyl, Ph means phenyl, MeO means methoxy, EtO means ethoxy, and CN means cyano. "⊖" means negative formal charge, and

"⊕" means positive formal charge. The abbreviation "dec." indicates that the compound appeared to decompose on melting. The abbreviation "Ex." stands for "Example" and is followed by a number indicating in which example the compound is prepared.

INDEX TABLE A



Compound	R^1	R^2	R^3	R^4	m.p. (°C)
1 (Ex. 1)	*c*-Pr	$CO_2CH_2CH_3$	Br	NH_2	107–108
2 (Ex. 1)	*c*-Pr	CO_2CH_3	Br	NH_2	148–150
3	*i*-Pr	CO_2CH_3	Br	NH_2	107–109
4	*c*-Pr	$CO_2CH_2CH_3$	Cl	NH_2	87–89
5	*c*-Pr	CO_2CH_3	Br	$NHCH_3$	*
7	*c*-Pr	CO_2CH_3	I	NH_2	145–146
8	*c*-Pr	CO_2H	Br	NH_2	160–162
9 (Ex. 3)	*c*-Pr	CO_2CH_3	Cl	NH_2	143–145
10	*c*-Pr	CO_2CH_3	Br	$NHCH_2CO_2CH_3$	95–96
11	*c*-Pr	CH_2OCH_3	Br	NH_2	*
12	*c*-Pr	$CH_2CO_2CH_2CH_3$	Br	NH_2	*
13	*c*-Pr	$CH_2CO_2CH_3$	Br	NH_2	*
14	*c*-Pr	CO_2(*i*-Pr)	Br	NH_2	141–142
15	*c*-Pr	$CO_2CH_2CH_2CH_3$	Br	NH_2	86–90
16	*c*-Pr	$CO_2CH_2CH_2CH_2CH_3$	Br	NH_2	87–90
17	*c*-Pr	CO_2(*i*-Bu)	Br	NH_2	121–123
18	Ph	$CO_2CH_2CH_3$	Br	NH_2	110–111
19	*c*-Pr	CO_2CH_3	Br	$N{=}CHN(CH_3)_2$	*
20	*c*-Pr	$C(O)NH_2$	Br	NH_2	*
21	*c*-Pr	CH_2OH	Br	NH_2	182–185
22	*c*-Pr	CO_2CH_2Ph	Br	NH_2	129–131
23	Ph	CO_2CH_3	Br	NH_2	*
24	*c*-Pr	CHO	F	NH_2	*
25	*c*-Pr	CO_2CH_3	F	NH_2	*
26	*c*-Pr	CHO	Br	NH_2	*
27	*c*-Pr	CH=NOH	Br	NH_2	*
28	2-Me-*c*-Pr	CO_2CH_3	Br	NH_2	132–133

Compound	R^1	R^2	R^3	R^4	m.p. (°C)
30	*c*-Pr	$CO_2CH_2CH_3$	F	NH_2	*
31	*c*-Pr	$CH(Cl)CO_2CH_2CH_3$	Br	NH_2	*
32	*c*-Pr	$CH(CH_3)CO_2CH_2CH_3$	Br	NH_2	*
33	*c*-Pr	$CH_2CO_2CH_2CH_3$	Br	$N{=}CHN(CH_3)_2$	*
34	*c*-Pr	$CCl_2CO_2CH_2CH_3$	Br	NH_2	*
35	*c*-Pr	CO_2CH_3	Br	NHOH	*
36	*t*-Bu	$CO_2CH_2CH_3$	Br	NH_2	69–70
37	4-Cl-Ph	$CO_2CH_2CH_3$	Br	NH_2	120–121
38	*c*-Pr	$CO_2CH_2CH_3$	Br	$NH(CH_2)_2N(CH_3)_2$	*
39	*c*-Pr	$CO_2CH_2CH_3$	Br	$NHCH_2CH_2OCH_3$	*
40	*c*-Pr	$CO_2CH_2CH_3$	Br	$N{=}CHN(CH_3)_2$	*
41	4-Cl-Ph	$CH_2CO_2CH_2CH_3$	Br	NH_2	*
42	*c*-Pr	$CO_2CH_2CH_3$	Br	$NHNH_2$	*
43	4-F-Ph	CO_2CH_3	Cl	NH_2	*
44	4-CF_3-Ph	CO_2CH_3	Cl	NH_2	*
45	*c*-Pr	$CH(OCH_2CH_3)_2$	Br	NH_2	*
46	*c*-Pr	$CH(OCH_3)_2$	F	NH_2	*
47	*c*-Pr	$CH(CO_2CH_2CH_3)OC(O)CH_3$	Br	NH_2	*
48	*c*-Pr	$CH{=}NOCH_3$	Br	NH_2	*
49	*c*-Pr	$CH{=}NNHCH_3$	Br	NH_2	*
50	*c*-Pr	$CH{=}NN(CH_3)_2$	Br	NH_2	*
51	*c*-Pr	$CH{=}NNHC(O)CH_3$	Br	NH_2	*
52	*c*-Pr	$CO_2CH_2CH_3$	Br	$NHOCH_3$	*
53	*c*-Pr	$CO_2CH_2CH_3$	Br	$NHC(O)CH_3$	*
54	*c*-Pr	$CO_2CH_2CH_3$	Br	$NHOCH_2Ph$	*
55	*c*-Pr	$CO_2CH_2CH_3$	Br	NHO(*t*-Bu)	*
56	*c*-Pr	$CO_2CH_2CH_3$	Br	$N\{CH_2(CH_2)_2CH_2\}$	*
57	*c*-Pr	$C(OH)CO_2CH_2CH_3$	Br	NH_2	*
58	4-Cl-Ph	CO_2CH_3	Cl	NH_2	215–218
59	*c*-Pr	CO_2CH_3	OMe	NH_2	*
60	4-CF_3-Ph	$CO_2CH_2CH_3$	Br	NH_2	*
61	4-CH_3-Ph	$CO_2CH_2CH_3$	Br	NH_2	*
62	4-CH_3-Ph	$CO_2CH_2CH_3$	Cl	NH_2	*
63	4-F-Ph	$CO_2CH_2CH_3$	Br	NH_2	*
64 (Ex. 5)	4-Cl-Ph	$CO_2CH_2CH_3$	Cl	NH_2	132–133
65 (Ex. 4)	4-Cl-Ph	CO_2H	Cl	NH_2	158–160 dec.

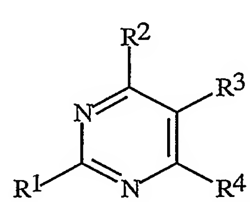
Compound	R^1	R^2	R^3	R^4	m.p. (°C)
66	3,4-di-Cl-Ph	$CO_2CH_2CH_3$	Br	NH_2	*
67	2,4-di-Cl-Ph	$CO_2CH_2CH_3$	Br	NH_2	*
68	1,3-benzodioxol-5-yl	$CO_2CH_2CH_3$	Br	NH_2	*
69	2-F-4-Cl-Ph	$CO_2CH_2CH_3$	Br	NH_2	*
70	3,4-di-Me-Ph	$CO_2CH_2CH_3$	Br	NH_2	*
71	3,4-di-Me-Ph	$CO_2CH_2CH_3$	Cl	NH_2	*
72	2,4-di-Cl-Ph	$CO_2CH_2CH_3$	Cl	NH_2	*
73	3,4-di-Cl-Ph	$CO_2CH_2CH_3$	Cl	NH_2	*
74	1,3-benzodioxol-5-yl	$CO_2CH_2CH_3$	Cl	NH_2	*
75	*c*-Pr	$CO_2CH_2CH_2CH_3$	Cl	NH_2	87–90
76	*c*-Pr	$CO_2CH_2CH_2CH_2CH_3$	Cl	NH_2	97–99
77	*c*-Pr	$C(O)O^{\ominus}\ Na^{\oplus}$	Cl	NH_2	297 dec.
78	*c*-Pr	CO_2CH_2Ph	Cl	NH_2	126–128
79	*c*-Pr	CO_2CH_3	Cl	$NHCH_3$	*
80	*c*-Pr	CO_2CH_2(4-Cl-Ph)	Cl	NH_2	123–125
81	*c*-Pr	$C(O)NHCH_3$	Cl	NH_2	*
82	4-Me-Ph	CO_2CH_3	Br	NH_2	*
83	4-Cl-Ph	CO_2CH_3	Br	NH_2	*
84	4-Me-Ph	CO_2CH_3	Cl	NH_2	*
85	*c*-Pr	$C(O)NH_2$	Cl	NH_2	232–236
86	3-F-4-Me-Ph	CO_2CH_3	Cl	NH_2	185–186
87	3-F-4-Me-Ph	CO_2H	Cl	NH_2	150 dec.
88	4-Cl-Ph	CO_2H	Br	NH_2	*
89	4-Me-Ph	CO_2H	Br	NH_2	*
90	4-F-Ph	CO_2H	Cl	NH_2	*
91	4-Me-Ph	CO_2H	Cl	NH_2	*
92	4-F-Ph	CO_2CH_3	Br	NH_2	*
93	4-F-Ph	CO_2H	Br	NH_2	*
94	4-Br-Ph	$CO_2CH_2CH_3$	Cl	NH_2	136–137
95	4-Br-Ph	CO_2H	Cl	NH_2	157–158 dec.
96	4-Br-Ph	CO_2CH_3	Cl	NH_2	223–224
97	3-Me-Ph	CO_2CH_3	Cl	NH_2	*
98	4-MeO-Ph	$CO_2CH_2CH_3$	Cl	NH_2	*
99	4-Et-Ph	$CO_2CH_2CH_3$	Cl	NH_2	*
100	3-Cl-Ph	$CO_2CH_2CH_3$	Cl	NH_2	*
101	3-Br-5-MeO-Ph	$CO_2CH_2CH_3$	Cl	NH_2	110–112

Compound	R^1	R^2	R^3	R^4	m.p. (°C)
102	4-Cl-Ph	CO_2(*i*-Pr)	Cl	NH_2	153–156
103	4-CF_3O-Ph	$CO_2CH_2CH_3$	Cl	NH_2	*
104	4-CF_3-Ph	$CO_2CH_2CH_3$	Cl	NH_2	138–140
105	4-Cl-Ph	$CO_2CH_2CH_2CH_3$	Cl	NH_2	80–81
106	2-F-Ph	$CO_2CH_2CH_3$	Cl	NH_2	120–124
107	3-CF_3-Ph	$CO_2CH_2CH_3$	Cl	NH_2	121–122
108	*i*-Pr	$CO_2CH_2CH_3$	Cl	NH_2	102–103
109	*i*-Pr	$C(O)O^{\ominus}\ Na^{\oplus}$	Cl	NH_2	190–192 dec.
110	*i*-Pr	CO_2CH_3	Cl	NH_2	100–104 dec.
111	4-Cl-Ph	CO_2CH_3	Cl	$NHCH_3$	124–126
112	*c*-Pr	$OCH_2CO_2CH_3$	Cl	NH_2	148–150
113	*c*-Pr	$C(O)O^{\ominus}\ Na^{\oplus}$	Br	NH_2	>300
114	4-Cl-Ph	$OCH_2CO_2CH_2CH_3$	Cl	NH_2	*
115	*c*-Pr	$OCH_2CO_2CH_2CH_3$	Cl	NH_2	164–168
116	*c*-Pr	$OCH_2C(O)O^{\ominus}\ Na^{\oplus}$	Cl	NH_2	264–267 dec.
117	4-Cl-Ph	$C(O)O^{\ominus}\ Na^{\oplus}$	Cl	NH_2	>300
118	4-Cl-Ph	CO_2CH_2Ph	Cl	NH_2	150–153
119	4-Cl-Ph	$OCH_2CO_2CH_3$	Cl	NH_2	129–132
120	4-Cl-Ph	$CH_2CO_2CH_2CH_3$	Cl	NH_2	*
121	4-MeS-Ph	CO_2CH_3	Cl	NH_2	169–173
122	4-MeS(O)$_2$-Ph	CO_2CH_3	Cl	NH_2	173–175
123	4-MeS(O)-Ph	CO_2CH_3	Cl	NH_2	173–175
124	*c*-Pr	CO_2CH_3	Br	$NHN{=}CHCH_3$	*
125	*c*-Pr	$CO_2CH_2CH_3$	Br	$NHOCH_2CO_2H$	*
126	*c*-Pr	$CO_2CH_2CH_3$	Br	$NHNHC(O)CH_3$	*
127	2-naphthalenyl	$CO_2CH_2CH_3$	Cl	NH_2	*
128	4-I-Ph	CO_2CH_3	Br	NH_2	192–195
129	4-Br-Ph	CO_2CH_3	Br	NH_2	204–206
130	4-Br-Ph	$C(O)NH_2$	Br	NH_2	234–236
131	4-Cl-Ph	$C(O)NHSO_2CH_3$	Cl	NH_2	243–245
132	*c*-Pr	$C(O)NHSO_2CH_3$	Cl	NH_2	227–233
133	4-I-Ph	$CO_2CH_2CH_3$	Cl	NH_2	140–142
134	4-I-Ph	$CH(OCH_3)_2$	Cl	NH_2	176–179
135 (Ex. 2)	*c*-Pr	CO_2H	Cl	NH_2	144–146

Compound	R^1	R^2	R^3	R^4	m.p. (°C)
136	4-Br-Ph	CO_2H	Br	NH_2	167–170
137	4-Cl-Ph	$CO_2CH_2CH_3$	I	NH_2	116–119
138	4-I-Ph	$CH(OCH_2CH_3)_2$	Cl	NH_2	*
139	*c*-Pr	$CO_2CH_2CH_2O$(*n*-Bu)	Cl	NH_2	64–66
141	*c*-Pr	$CO_2CH_2CH_2OCH_2CH_2OCH_3$	Cl	NH_2	79–80
143	*c*-Pr	$CO_2CH_2CH_2CH_2OH$	Cl	NH_2	91–94
144	*c*-Pr	$C(O)O^{\ominus}$ (*i*-Pr)$NH_3^{\oplus}$	Cl	NH_2	170 dec.
145	*c*-Pr	CO_2(4-Cl-Ph)	Cl	NH_2	145–147
146	*c*-Pr	$CO_2N{=}C(CH_3)_2$	Cl	NH_2	101–103
148	*c*-Pr	$CO_2CH_2CO_2CH_3$	Cl	NH_2	107–108
151	*c*-Pr	$C(O)O^{\ominus}$ (*c*-hexyl)$NH_3^{\oplus}$	Cl	NH_2	170 dec.
152	*c*-Pr	$C(O)O^{\ominus}$ $[(CH_2)_2O(CH_2)_2]NH_2^{\oplus}$	Cl	NH_2	189–190 dec.
153	*c*-Pr	$C(O)O^{\ominus}$ $(HOCH_2CH_2)_2NH_2^{\oplus}$	Cl	NH_2	118–124
154	*c*-Pr	$C(O)O^{\ominus}$ $(CH_3CH_2)_3NH^{\oplus}$	Cl	NH_2	138–141 dec.
155	*c*-Pr	$C(O)O^{\ominus}$ pyridine-$H^{\oplus}$	Cl	NH_2	144–147 dec.
156	*c*-Pr	$C(O)O^{\ominus}$ $Li^{\oplus}$	Cl	NH_2	280 dec.
157	*c*-Pr	$C(O)O^{\ominus}$ $K^{\oplus}$	Cl	NH_2	273 dec.
158	*c*-Pr	$C(O)O^{\ominus}$ $Cs^{\oplus}$	Cl	NH_2	300 dec.
159	*c*-Pr	$C(O)O^{\ominus}$ $(CH_3)_4N^{\oplus}$	Cl	NH_2	263 dec.
160	*c*-Pr	$C(O)O^{\ominus}$ $(CH_3)_3S^{\oplus}$	Cl	NH_2	157 dec.
161	*c*-Pr	$C(O)O^{\ominus}$ $HOCH_2CH_2NH_3^{\oplus}$	Cl	NH_2	168 dec.
162	*c*-Pr	$C(O)O^{\ominus}$ $(HOCH_2CH_2)_3NH^{\oplus}$	Cl	NH_2	125–128
163	*c*-Pr	$C(O)O^{\ominus}$ $(CH_3)_2NH_2^{\oplus}$	Cl	NH_2	170 dec.
164	*c*-Pr	$CO_2(CH_2)_7CH_3$	Cl	NH_2	73–74
165	*c*-Pr	CO_2(*i*-Pr)	Cl	NH_2	143–144
166	*c*-Pr	$CO_2CH(CH_3)(CH_2)_5CH_3$	Cl	NH_2	82–85
167	*c*-Pr	$CO_2CH_2CH(C_2H_5)(CH_2)_3CH_3$	Cl	NH_2	60–62

* See Index Table D for ^1H NMR data.

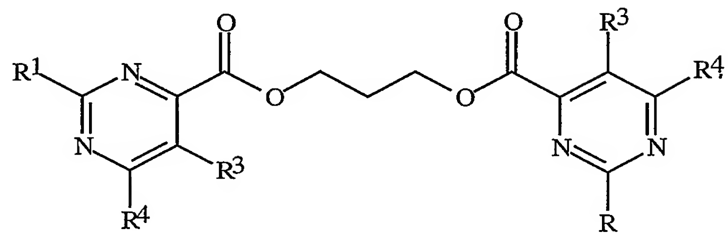
INDEX TABLE B



Compound	R^1	R^2	R^3	R^4	m.p. (°C)
140	*c*-Pr	CO_2CH_2(2-oxiranyl)	Cl	NH_2	*
147	*c*-Pr	CO_2CH_2(2,2-di-Me-1,3-dioxlan-4-yl)	Cl	NH_2	104–105
149	*c*-Pr	CO_2CH_2(2-oxo-1,3 dioxlan-4-yl)	Cl	NH_2	142–150
150	*c*-Pr	CO_2CH_2(tetrahydro-2-furanyl)	Cl	NH_2	114–116

* See Index Table D for ^{1}H NMR data.

INDEX TABLE C



Compound	R^1	R^3	R^4	m.p. (°C)
142	*c*-Pr	Cl	NH_2	107–108

* See Index Table D for ^{1}H NMR data.

INDEX TABLE D

Compound	^{1}H NMR Data ($CDCl_3$ solution unless indicated otherwise)[a]
5	δ 5.60 (br s, 1H), 3.96 (s, 3H), 3.02 (d, 3H), 2.10 (m, 1H), 1.10 (m, 2H), 0.98 (m, 2H).
11	δ 5.20 (br s, 2H), 4.97 (s, 2H), 3.49 (s, 3H), 2.07 (m, 1H), 1.02 (m, 2H), 0.95 (m, 2H).
12	δ 5.20 (br s, 2H), 4.18 (q, 2H), 3.80 (s, 2H), 1.90 (m, 1H), 1.25 (t, 3H), 1.01–0.93 (m, 4H).
13	δ 5.26 (br s, 2H), 3.82 (s, 2H), 3.73 (s, 3H), 1.90 (m, 1H), 1.02–0.92 (m, 4H).
19	δ 8.60 (s, 1H), 3.97 (s, 3H), 3.20 (s, 3H), 3.19 (s, 3H), 2.10 (m, 1H), 1.08 (m, 2H), 0.99 (m, 2H).
20	δ 7.65 (br s, 1H), 5.94 (br s, 2H), 5.8 (br s, 1H), 2.01 (m, 1H), 1.03 (m, 4H).
23	δ 8.35 (m, 2H), 7.46 (m, 3H), 5.61 (br s, 2H), 4.02 (s, 3H).
24	δ 10.01 (s, 1H), 5.31 (br s, 2H), 2.10 (m, 1H), 1.10–0.95 (m, 4H).
25	δ 5.15 (br s, 2H), 3.98 (s, 3H), 2.03 (m, 1H), 1.04–0.92 (m, 4H).
26	δ 9.98 (s, 1H), 5.60 (br s, 2H), 2.10 (m, 1H), 1.10–1.02 (m, 4H).
27	δ 8.19 (s, 1H), 1.89 (m, 1H), 0.92–0.87 (m, 4H).
30	δ 5.12 (br s, 2H), 4.45 (q, 2H), 2.13 (m, 1H), 1.41 (t, 3H), 1.04–0.92 (m, 4H).
31	δ 5.66 (s, 1H), 5.34 (br s, 2H), 4.30 (q, 2H), 1.98 (m, 1H), 1.30 (t, 3H), 1.13–0.92 (m, 4H).
32	δ 5.26 (br s, 2H), 4.21–4.07 (m, 3H), 1.94 (m, 1H), 1.45 (d, 2H), 1.22 (t, 3H), 1.08–0.90 (m, 4H).
33	δ 8.57 (s, 1H), 4.18 (q, 2H), 3.88 (s, 2H), 3.18 (s, 3H), 3.16 (s, 3H), 2.00 (m, 1H), 1.24 (t, 3H), 1.05–0.96 (m, 4H).
34	δ 5.48 (br s, 2H), 4.38 (q, 2H), 2.02 (m, 1H), 1.36 (t, 3H), 1.11–0.97(m, 4H).

Compound	^{1}H NMR Data ($CDCl_3$ solution unless indicated otherwise)[a]
35	δ 3.97 (s, 3H), 2.07 (m, 1H), 1.20–1.13 (m, 2H), 1.12–1.04 (m, 2H).
38	δ 6.20 (br s, 1H), 4.43 (q, 2H), 3.48 (m, 2H), 2.50 (m, 2H), 2.27 (s, 6H), 2.07 (m, 1H), 1.41 (t, 3H), 1.07 (m, 2H), 0.96 (m, 2H).
39	δ 5.90 (br s, 1H), 4.43 (q, 2H), 3.65 (m, 2H), 3.54 (m, 2H), 3.39 (s, 3H), 2.08 (m, 1H), 1.41 (t, 3H), 1.04 (m, 2H), 0.98 (m, 2H).
40	δ 8.59 (s, 1H), 4.44 (q, 2H), 3.20 (s, 3H), 3.18 (s, 3H), 2.10 (m, 1H), 1.41 (t, 3H), 1.11–1.05 (m, 2H), 1.01–0.94 (m, 2H).
41	δ 8.27 (m, 2H), 7.39 (m, 2H), 5.39 (br s, 2H), 4.23 (q, 2H), 3.93 (s, 2H), 1.29 (t, 3H).
42	δ 6.70 (br s, 1H), 4.43 (q, 2H), 4.0 (br s, 2H), 2.10 (m, 1H), 1.41 (t, 3H), 1.11 (m, 2H), 1.01 (m, 2H).
43	δ 8.35 (m, 2H), 7.10 (dd, 2H), 5.54 (br s, 2H), 4.02 (s, 3H).
44	δ 8.47 (d, 2H), 7.69 (d, 2H), 5.61 (br s, 2H), 4.04 (s, 3H).
45	δ 5.56 (s, 1H), 5.29 (br s, 2H), 3.86–3.74 (m, 2H), 3.71–3.58 (m, 2H), 2.14–2.03 (m, 1H), 1.30–1.23 (m, 6H), 1.07–0.89 (m, 4H).
46	δ 5.39 (s, 1H), 4.96 (br s, 2H), 3.49 (s, 6H), 2.15–2.04 (m, 1H), 1.02–0.87 (m, 4H).
47	δ 6.32 (s, 1H), 5.34 (br s, 2H), 4.28 (q, 2H), 2.21 (s, 3H), 2.03–1.93 (m, 1H), 1.28 (t, 3H), 1.11–0.91 (m, 4H).
48	δ 8.41 (s, 1H), 5.34 (br s, 2H), 4.12 (s, 3H), 2.19–2.10 (m, 1H), 0.90–0.80 (m, 4H).
49	(DMSO-d_6) δ 8.45 (q, 1H), 7.34 (s, 1H), 6.82 (br s), 2.86 (d, 3H), 1.91–1.81 (m, 1H), 1.07–0.92 (m, 4H).
50	δ 7.23 (s, 1H), 5.18 (br s, 2H), 3.21 (s, 6H), 2.19–2.08 (m, 1H), 1.05–0.88 (m, 4H).
51	(DMSO-d_6) δ 11.68 + 11.55 (2 x s, 1H), 8.39 + 8.09 (2 x s, 1H), 2.20 + 1.97 (2 x s, 3H), 1.97–1.86 (m, 1H), 0.90 (d, 4H).
52	δ 8.76 + 8.07 (2 x s, 1H), 4.50–4.32 (br s, 2H), 3.94 + 3.89 (2 x s, 3H), 2.26–2.11 (br m, 1H), 1.40 (br s, 3H), 1.20–1.12 (m, 2H), 1.09–1.00 (m, 2H).
53	δ 4.49 (q, 2H), 2.30 (s, 3H), 2.3–2.2 (m, 1H), 1.43 (t, 3H), 1.27–1.09 (m, 4H).
54	δ 7.47–7.34 (m, 5H), 5.06 (s, 2H), 4.43 (q, 2H), 1.90–1.84 (m, 1H), 1.41 (t, 3H), 1.23–1.03 (m, 4H).
55	δ 8.64 + 7.64 (2 x s, 1H), 4.45 + 4.36 (2 x q, 2H), 2.20–2.10 (m, 1H), 1.42 + 1.37 (2 x t, 3H), 1.34 + 1.32 (2 x s, 9H), 1.18–0.98 (m, 4H).
56	δ 4.42 (q, 2H), 3.77 (m, 4H), 2.07–1.97 (m, 1H), 1.91 (m, 4H), 1.40 (t, 3H), 1.07–0.89 (m, 4H).
57	δ 5.37–5.30 (m, 3H), 4.51 (d, 1H), 4.28–4.16 (m, 2H), 2.06–1.96 (m, 1H), 1.27 (t, 3H), 1.09–0.94 (m, 4H).
59	δ 5.14 (br s, 2H), 3.97 (s, 3H), 3.84 (s, 3H), 2.09 (m, 1H), 1.00 (m, 2H), 0.94 (m, 2H).
60	δ 8.46 (d, 2H), 7.69 (d, 2H), 5.65 (br s, 2H), 4.50 (m, 2H), 1.46 (t, 3H).

Compound	^{1}H NMR Data ($CDCl_3$ solution unless indicated otherwise)[a]
61	δ 8.23 (d, 2H), 7.24 (d, 2H), 5.57 + 5.53 (2 x br s, 2H), 4.49 (m, 2H), 2.40 (s, 3H), 1.45 (t, 3H).
62	δ 8.23 (d, 2H), 7.24 (d, 2H), 5.53 (br s, 2H), 4.49 (m, 2H), 2.40 (s, 3H), 1.45 (t, 3H).
63	δ 8.35 (m, 2H), 7.11 (t, 2H), 5.57 (br s, 2H), 4.49 (m, 2H), 1.45 (t, 3H).
66	δ 8.46 (d, 1H), 8.20 (dd, 1H), 7.50 (d, 1H), 5.62 (br s, 2H), 4.50 (m, 2H), 1.46 (t, 3H).
67	δ 7.67 (d, 1H), 7.48 (d, 1H), 7.32 (dd, 1H), 5.69 (br s, 2H), 4.47 (m, 2H), 1.43 (t, 3H).
68	δ 7.96 (dd, 1H), 7.83 (d, 1H), 6.85 (d, 1H), 6.02 (s, 2H), 5.53 (br s, 2H), 4.48 (m, 2H), 1.45 (t, 3H).
69	δ 8.97 (t, 1H), 7.23–7.15 (m, 2H), 5.67 (br s, 2H), 4.48 (m, 2H), 1.44 (t, 3H).
70	δ 8.11 (m, 1H), 8.06 (m, 1H), 7.19 (d, 1H), 5.57 (br s, 2H), 4.49 (m, 2H), 2.32 (t, 3H), 2.30 (t, 3H), 1.45 (t, 3H).
71	δ 8.11 (m, 1H), 8.06 (m, 1H), 7.20 (d, 1H), 5.50 (br s, 2H), 4.49 (m, 2H), 2.33 (t, 3H), 2.31 (t, 3H), 1.45 (t, 3H).
72	δ 7.67 (d, 1H), 7.48 (d, 1H), 7.32 (dd, 1H), 5.63 (br s, 2H), 4.48 (m, 2H), 1.43 (t, 3H).
73	δ 8.46 (d, 1H), 8.20 (dd, 1H), 7.50 (d, 1H), 5.56 (br s, 2H), 4.50 (m, 2H), 1.46 (t, 3H).
74	δ7.95 (dd, 1H), 7.83 (d, 1H), 6.86 (d, 1H), 6.02 (s, 2H), 5.48 (br s, 2H), 4.48 (m, 2H), 1.45 (t, 3H).
79	δ 5.56 (br s, 1H), 3.97 (s, 3H), 3.04 (d, 3H), 2.11 (m, 1H), 1.10 (m, 2H), 0.98 (m, 2H).
81	δ 7.82 (br s, 1H), 5.48 (br s, 2H), 2.97 (d, 3H), 2.01 (m, 1H), 1.04 (m, 2H), 0.99 (m, 2H).
82	δ 8.22 (d, 2H), 7.24 (d, 2H), 5.57 + 5.52 (2 x br s, 2H), 4.02 (s, 3H), 2.40 (s, 3H).
83	δ 8.29 (d, 2H), 7.40 (d, 2H), 5.60 (br s, 2H), 4.02 (s, 3H).
84	δ 8.22 (d, 2H), 7.24 (d, 2H), 5.53 (br s, 2H), 4.02 (s, 3H), 2.40 (s, 3H).
88	(DMSO-d_6) δ 14.1–13.9 (br s), 8.25 (d, 2H), 7.56 (d, 2H).
89	(DMSO-d_6) δ 8.15 (d, 2H), 7.29 (d, 2H), 2.36 (s, 3H).
90	(DMSO-d_6) δ 14.2–13.9 (br s), 8.29 (m, 2H), 7.31 (t, 2H).
91	δ 8.18 (d, 2H), 7.30 (d, 2H), 5.84 (br s, 2H), 2.43 (s, 3H).
92	δ 8.35 (m, 2H), 7.11 (t, 2H), 5.59 (br s, 2H), 4.02 (s, 3H).
93	δ 8.32 (m, 2H), 7.17 (t, 2H), 5.96 (br s, 2H).
97	δ 8.11 (m, 2H), 7.31 (m, 2H), 5.57 (br s, 2H), 4.02 (s, 3H), 2.42 (s, 3H).
98	δ 8.30 (d, 2H), 6.94 (d, 2H), 5.48 (br s, 2H), 4.49 (q, 2H), 3.86 (s, 3H), 1.45 (t, 3H).
99	δ 8.24 (d, 2H), 7.26 (d, 2H), 5.51 (br s, 2H), 4.49 (q, 2H), 2.70 (q, 2H) 1.45 (t, 3H), 1.26 (t, 3H).
100	δ 8.35 (s, 1H), 8.24 (d, 1H), 7.46–7.34 (m, 2H), 5.56 (br s, 2H), 4.50 (q, 2H), 1.46 (t, 3H).
103	δ 8.39 (d, 2H), 7.27 (d, 2H), 5.47 (br s, 2H), 4.50 (q, 2H), 1.45 (t, 3H).
114	δ 8.19 (d, 2H), 7.38 (d, 2H), 5.26 (br s, 2H), 4.98 (s, 2H), 4.24 (q, 2H), 1.26 (t, 3H).
120	δ 8.27 (d, 2H), 7.39 (d, 2H), 5.34 (br s, 2H), 4.23 (q, 2H), 3.91 (s, 2H), 1.29 (t, 3H).

Compound	^{1}H NMR Data ($CDCl_3$ solution unless indicated otherwise)[a]
124	δ 8.61 + 8.48 (2 x s, 1H), 7.48 + 7.12 (2 x q, 1H), 3.98 + 3.96 (2 x s, 3H), 2.30–2.15 (m, 1H), 2.14 + 2.00 (2 x d, 3H), 1.19–1.12 (2 x m, 2H), 1.06–0.97 (2 x m, 2H).
125	δ 4.61 + 4.54 (2 x br s, 2H), 4.47–4.36 (m, 2H), 2.18–1.98 (br m, 1H), 1.44–1.34 (m, 3H), 1.32–1.00 (br m, 4H).
126	δ 7.83 (d, 1H), 7.69 (d, 1H), 4.45 (q, 2H), 2.14 (s, 3H), 1.41 (t, 3H), 1.08-1.00 (m, 4H).
127	δ 8.89 (s, 1H), 8.43 (d, 1H), 7.97 (d, 1H), 7.92–7.83 (m, 2H), 7.57–7.46 (m, 2H), 5.57 (br s, 2H), 4.53 (q, 2H), 1.48 (t, 3H).
138	δ 8.11 (d, 2H), 7.76 (d, 2H), 5.65 (s, 1H), 5.39 (br s, 2H), 3.88 (m, 2H), 3.70 (m, 2H), 1.30 (t, 6H).
140	5.38 (br s, 2H), 4.44 (dd, 1H), 4.28 (dd, 1H), 3.35 (m, 1H), 2.88 (dd, 1H), 2.76 (dd, 1H), 2.07 (m, 1H), 1.05 (m, 2H), 1.00 (m, 2H).

a ^{1}H NMR data are in ppm downfield from tetramethylsilane. Couplings are designated by (s)-singlet, (d)-doublet, (t)-triplet, (q)-quartet, (m)-multiplet, (dd)-doublet of doublets, (dt)-doublet of triplets, (dq)-doublet of quartets, (br s)-broad singlet, (br d)-broad d, (br m)-broad multiplet.

BIOLOGICAL EXAMPLES OF THE INVENTION

TEST A

Seeds of barnyardgrass (*Echinochloa crus-galli*), crabgrass (*Digitaria sanguinalis*), giant foxtail (*Setaria faberi*), morningglory (*Ipomoea* spp.), redroot pigweed (*Amaranthus retroflexus*) and velvetleaf (*Abutilon theophrasti*) were planted into a blend of loam soil and sand and treated preemergence with a directed soil spray using test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant. At the same time these species were also treated with postemergence applications of test chemicals formulated in the same manner.

Plants ranged in height from 2 to 10 cm and were in the 1- to 2-leaf stage for the postemergence treatment. Treated plants and untreated controls were maintained in a greenhouse for approximately ten days, after which time all treated plants were compared to untreated controls and visually evaluated for injury. Plant response ratings, summarized in Table A, are based on a 0 to 100 scale where 0 is no effect and 100 is complete control. A dash (–) response means no test results.

Table A	Compounds	
2000 g ai/ha	1	57
Postemergence		
Barnyardgrass	75	75
Crabgrass	80	30
Foxtail, Giant	75	80
Morningglory	100	80
Pigweed	100	95
Velvetleaf	85	80

Table A	Compound
1000 g ai/ha	43
Postemergence	
Barnyardgrass	20
Crabgrass	30
Foxtail, Giant	10
Morningglory	45
Pigweed	85
Velvetleaf	50

Table A						Compounds								
500 g ai/ha	1	20	57	58	59	60	61	62	63	64	65	66	67	68
Postemergence														
Barnyardgrass	75	0	25	10	30	0	60	80	0	70	85	0	0	0
Crabgrass	65	0	10	10	10	0	5	35	0	70	80	0	5	0
Foxtail, Giant	70	0	60	50	35	0	25	80	0	80	95	0	0	0
Morningglory	95	40	70	80	100	20	30	35	25	95	95	30	60	35
Pigweed	100	60	75	80	80	40	50	60	65	100	100	65	90	55
Velvetleaf	95	55	50	85	85	40	100	95	70	100	100	75	75	60

Table A						Compounds								
500 g ai/ha	69	70	71	72	73	74	75	76	77	78	79	80	81	82
Postemergence														
Barnyardgrass	5	0	0	0	5	70	90	90	90	90	90	90	30	50
Crabgrass	40	20	5	30	35	60	90	70	90	80	75	70	10	0
Foxtail, Giant	55	0	0	0	45	70	90	90	90	80	90	90	30	0
Morningglory	90	10	0	70	65	30	90	95	100	90	95	95	80	40
Pigweed	90	20	30	95	80	70	100	95	95	95	100	95	75	75
Velvetleaf	90	60	55	85	75	80	100	100	100	90	95	90	75	90

Table A						Compounds								
500 g ai/ha	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Postemergence														
Barnyardgrass	10	80	0	30	90	85	85	10	90	0	0	60	90	25
Crabgrass	10	10	0	0	10	85	10	20	15	5	0	50	80	20
Foxtail, Giant	10	20	0	0	30	90	45	30	75	0	0	65	85	35
Morningglory	75	20	75	20	15	85	30	65	30	75	55	75	80	65
Pigweed	85	65	90	50	90	95	100	90	100	70	70	85	95	85
Velvetleaf	90	90	60	85	95	95	95	85	95	70	80	90	95	85

Table A	Compounds													
500 g ai/ha	97	98	99	100	101	102	103	104	105	106	107	108	109	110
Postemergence														
Barnyardgrass	10	20	0	10	0	0	0	10	25	5	0	5	10	10
Crabgrass	0	10	0	0	0	10	0	30	45	0	5	0	10	10
Foxtail, Giant	0	15	0	0	0	0	0	5	10	0	35	10	10	5
Morningglory	50	0	0	55	0	15	0	40	70	35	0	90	80	85
Pigweed	30	15	10	25	5	65	20	45	90	70	10	85	85	85
Velvetleaf	70	45	35	70	15	70	70	80	95	55	65	65	80	65

Table A	Compounds													
500 g ai/ha	111	112	113	114	115	116	117	118	119	120	121	122	123	127
Postemergence														
Barnyardgrass	10	0	90	0	0	0	90	0	5	40	5	0	10	0
Crabgrass	30	0	55	0	0	0	90	20	0	5	0	0	0	0
Foxtail, Giant	0	0	85	0	0	0	90	15	0	0	0	0	10	0
Morningglory	50	50	90	55	60	60	90	70	35	55	10	0	20	0
Pigweed	85	40	90	55	45	35	100	75	45	35	0	0	0	10
Velvetleaf	85	35	95	5	40	40	100	95	10	65	0	0	0	80

Table A	Compounds													
500 g ai/ha	128	129	130	131	132	133	134	135	136	137	138	139	140	141
Postemergence														
Barnyardgrass	0	0	0	20	10	40	0	90	80	0	0	90	90	90
Crabgrass	0	0	0	30	10	55	0	65	70	0	0	70	80	80
Foxtail, Giant	0	0	0	30	5	60	0	80	80	0	0	80	90	85
Morningglory	80	70	0	20	50	85	0	100	80	30	20	90	90	90
Pigweed	75	85	15	70	65	90	30	95	100	45	35	100	100	100
Velvetleaf	80	90	30	60	60	85	55	100	95	60	70	90	90	100

Table A	Compounds								
500 g ai/ha	142	143	144	145	146	147	148	149	150
Postemergence									
Barnyardgrass	75	75	90	60	90	90	90	90	95
Crabgrass	25	60	80	30	80	75	85	75	80
Foxtail, Giant	45	80	80	70	85	90	80	80	85
Morningglory	90	90	95	95	100	100	100	95	100
Pigweed	90	90	100	90	95	95	95	90	90
Velvetleaf	90	95	100	95	100	100	95	100	100

Table A	Compound
250 g ai/ha	43
Postemergence	
Barnyardgrass	10
Crabgrass	10
Foxtail, Giant	10
Morningglory	20
Pigweed	60
Velvetleaf	50

Table A	Compounds													
125 g ai/ha	20	58	59	60	61	62	63	64	65	66	67	68	69	70
Postemergence														
Barnyardgrass	0	5	0	0	35	15	0	25	85	0	0	0	0	0
Crabgrass	0	5	0	0	0	0	0	50	55	0	5	0	20	0
Foxtail, Giant	0	0	0	0	0	0	0	70	85	0	0	0	0	0
Morningglory	20	55	90	0	10	10	20	80	75	20	50	15	75	0
Pigweed	40	70	60	10	25	30	40	90	100	50	90	50	90	15
Velvetleaf	10	70	60	30	70	90	55	95	95	50	65	60	85	35

Table A	Compounds													
125 g ai/ha	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Postemergence														
Barnyardgrass	0	0	0	30	85	90	90	80	85	55	0	40	0	55
Crabgrass	0	10	15	30	80	45	70	70	40	30	0	0	0	0
Foxtail, Giant	0	0	15	60	90	90	85	70	80	70	0	0	0	0
Morningglory	0	55	50	40	90	90	95	80	90	90	50	20	55	5
Pigweed	5	95	75	60	90	85	95	85	90	65	55	45	70	60
Velvetleaf	40	85	70	70	85	80	95	75	90	65	50	90	90	75

Table A	Compounds													
125 g ai/ha	85	86	87	88	89	90	91	92	93	94	95	96	97	98
Postemergence														
Barnyardgrass	0	10	50	50	60	0	75	0	0	30	75	20	30	0
Crabgrass	0	0	0	60	0	0	5	0	0	35	70	5	0	0
Foxtail, Giant	0	0	0	80	10	0	5	0	0	45	85	25	0	0
Morningglory	20	0	0	60	0	20	5	45	40	70	75	60	45	0
Pigweed	75	20	55	90	50	35	55	35	45	80	85	70	10	5
Velvetleaf	25	70	90	90	70	65	75	45	65	90	90	80	60	35

Table A 125 g ai/ha Postemergence	Compounds 99	100	101	102	103	104	105	106	107	108	109	110	111	112
Barnyardgrass	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Crabgrass	0	0	0	10	0	15	20	0	0	0	0	0	5	0
Foxtail, Giant	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Morningglory	0	40	0	0	0	25	50	20	0	70	70	70	20	55
Pigweed	5	10	0	50	0	30	65	15	10	50	60	55	55	20
Velvetleaf	0	50	0	45	45	70	85	25	35	35	25	40	75	20

Table A 125 g ai/ha Postemergence	Compounds 113	114	115	116	117	118	119	120	121	122	123	127	128	129
Barnyardgrass	55	0	0	0	85	0	0	10	0	0	0	0	0	0
Crabgrass	25	0	0	0	75	10	0	0	0	0	0	0	0	0
Foxtail, Giant	65	0	0	0	80	0	0	0	0	0	0	0	0	0
Morningglory	90	40	35	40	90	65	40	25	0	0	0	0	55	60
Pigweed	80	45	10	20	100	60	25	20	0	0	0	0	55	80
Velvetleaf	80	0	30	15	100	90	0	50	0	0	0	60	65	80

Table A 125 g ai/ha Postemergence	Compounds 130	131	132	133	134	135	136	137	138	139	140	141	142	143
Barnyardgrass	0	10	0	10	0	75	50	0	0	80	70	80	45	55
Crabgrass	0	10	5	30	0	65	35	0	0	60	65	25	15	5
Foxtail, Giant	0	15	0	15	0	75	75	0	0	80	85	40	30	25
Morningglory	0	0	45	70	0	90	70	5	0	80	85	90	90	90
Pigweed	0	50	50	80	15	90	85	25	20	90	90	90	85	70
Velvetleaf	0	35	50	80	50	85	85	45	60	85	90	85	80	75

Table A 125 g ai/ha Postemergence	Compounds 144	145	146	147	148	149	150
Barnyardgrass	60	30	70	80	68	65	80
Crabgrass	40	5	20	25	10	25	65
Foxtail, Giant	70	20	80	60	45	60	80
Morningglory	85	80	85	85	90	80	80
Pigweed	85	80	90	85	75	75	90
Velvetleaf	95	75	85	80	75	85	90

Table A	Compounds	
2000 g ai/ha	1	57
Preemergence		
Barnyardgrass	80	80
Crabgrass	75	70
Foxtail, Giant	85	70
Morningglory	100	100
Pigweed	100	100
Velvetleaf	80	95

Table A	Compound
1000 g ai/ha	43
Preemergence	
Barnyardgrass	10
Crabgrass	10
Foxtail, Giant	10
Morningglory	45
Pigweed	75
Velvetleaf	20

Table A	Compounds													
500 g ai/ha	1	20	57	58	59	60	61	62	63	64	65	66	67	68
Preemergence														
Barnyardgrass	60	0	25	0	15	0	10	45	40	60	90	0	0	0
Crabgrass	25	0	10	0	0	0	30	60	75	90	90	15	30	0
Foxtail, Giant	40	0	10	10	0	0	10	0	35	70	80	0	30	0
Morningglory	85	60	100	25	100	0	15	35	0	70	90	0	0	0
Pigweed	85	70	90	60	70	0	30	75	80	100	100	10	75	15
Velvetleaf	60	70	80	40	45	0	50	75	15	95	95	35	40	10

Table A	Compounds													
500 g ai/ha	69	70	71	72	73	74	75	76	77	78	79	80	81	82
Preemergence														
Barnyardgrass	15	0	0	0	30	50	95	90	100	75	80	80	20	15
Crabgrass	75	20	0	0	35	50	90	75	80	70	80	85	10	0
Foxtail, Giant	50	5	0	0	15	40	90	85	95	65	95	70	10	0
Morningglory	0	0	0	0	0	30	100	100	100	100	100	100	50	0
Pigweed	85	10	15	100	60	40	95	90	95	90	100	90	70	70
Velvetleaf	65	35	50	55	40	50	95	100	100	85	90	90	40	35

Table A	Compounds													
500 g ai/ha	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Preemergence														
Barnyardgrass	5	25	0	0	20	55	50	35	80	0	30	40	80	10
Crabgrass	5	15	5	0	75	85	60	50	75	0	45	55	85	65
Foxtail, Giant	0	20	0	0	0	50	10	15	25	0	35	40	90	10
Morningglory	10	0	20	0	20	90	0	25	50	0	5	35	85	80
Pigweed	50	80	60	5	100	100	100	80	100	45	90	95	100	80
Velvetleaf	30	70	10	10	95	70	75	45	100	45	85	90	95	80

Table A	Compounds													
500 g ai/ha	97	98	99	100	101	102	103	104	105	106	107	108	109	110
Preemergence														
Barnyardgrass	0	0	0	0	0	0	0	5	0	5	0	15	25	15
Crabgrass	25	15	0	0	0	0	0	10	0	0	5	20	25	15
Foxtail, Giant	5	0	0	0	0	0	0	5	0	0	0	0	5	0
Morningglory	0	0	0	0	0	0	0	0	0	0	0	90	95	90
Pigweed	70	0	0	0	0	15	10	10	0	30	0	75	80	65
Velvetleaf	50	5	0	0	0	20	10	10	0	30	10	50	50	35

Table A	Compounds													
500 g ai/ha	111	112	113	114	115	116	117	118	119	120	121	122	123	127
Preemergence														
Barnyardgrass	0	10	80	0	20	20	85	10	10	15	0	0	0	0
Crabgrass	0	10	70	0	10	10	75	25	0	0	0	0	0	0
Foxtail, Giant	0	0	80	0	0	0	85	15	0	0	0	0	0	0
Morningglory	0	10	100	0	35	50	85	0	0	0	0	0	0	0
Pigweed	0	30	90	0	40	50	100	55	0	0	0	0	0	0
Velvetleaf	0	10	95	0	10	15	100	15	0	0	0	0	0	0

Table A	Compounds													
500 g ai/ha	128	129	130	131	132	133	134	135	136	137	138	139	140	141
Preemergence														
Barnyardgrass	0	0	0	0	0	15	0	90	40	0	0	90	90	75
Crabgrass	0	0	0	0	0	45	0	95	60	0	0	90	90	85
Foxtail, Giant	0	0	0	0	0	30	0	85	60	0	0	90	85	85
Morningglory	0	0	0	0	0	35	0	100	20	0	0	100	95	95
Pigweed	0	15	0	0	65	65	0	100	100	0	0	100	95	85
Velvetleaf	0	5	0	0	5	30	0	100	75	0	0	90	95	85

Table A	Compounds								
500 g ai/ha	142	143	144	145	146	147	148	149	150
Preemergence									
Barnyardgrass	75	85	80	75	90	85	85	85	80
Crabgrass	85	95	95	80	75	80	90	75	80
Foxtail, Giant	65	75	80	60	90	85	80	90	80
Morningglory	95	100	95	100	100	100	100	100	100
Pigweed	90	95	85	85	95	90	90	90	95
Velvetleaf	85	95	85	85	100	95	100	85	95

Table A	Compound
250 g ai/ha	43
Preemergence	
Barnyardgrass	0
Crabgrass	0
Foxtail, Giant	0
Morningglory	0
Pigweed	0
Velvetleaf	0

Table A	Compounds													
125 g ai/ha	20	58	59	60	61	62	63	64	65	66	67	68	69	70
Preemergence														
Barnyardgrass	0	0	0	0	0	0	0	0	50	0	0	0	0	0
Crabgrass	0	0	0	0	0	0	0	25	60	0	0	0	50	5
Foxtail, Giant	0	0	0	0	0	0	0	15	40	0	0	0	10	5
Morningglory	10	10	80	0	0	0	0	40	25	0	0	0	0	0
Pigweed	40	0	20	0	0	0	0	20	100	0	10	0	65	0
Velvetleaf	0	0	10	0	0	0	0	25	55	0	10	5	35	20

Table A	Compounds													
125 g ai/ha	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Preemergence														
Barnyardgrass	0	0	5	0	70	75	90	45	30	10	10	0	0	0
Crabgrass	0	0	5	20	85	30	70	55	30	45	0	0	0	0
Foxtail, Giant	0	0	0	0	75	70	75	10	40	15	0	0	0	0
Morningglory	0	0	0	0	95	100	100	90	55	90	0	0	0	0
Pigweed	0	75	15	0	90	80	85	75	90	80	60	0	20	0
Velvetleaf	30	40	35	30	80	90	100	80	60	75	20	5	15	15

Table A	Compounds													
125 g ai/ha	85	86	87	88	89	90	91	92	93	94	95	96	97	98
Preemergence														
Barnyardgrass	0	0	0	10	0	0	5	0	5	5	20	5	0	0
Crabgrass	0	0	10	35	0	10	25	0	25	45	65	50	15	0
Foxtail, Giant	0	0	0	10	0	0	0	0	5	20	65	5	5	0
Morningglory	0	0	0	10	0	0	5	0	0	30	80	15	0	0
Pigweed	50	0	85	80	80	70	100	15	80	90	95	80	25	0
Velvetleaf	0	0	25	10	20	10	80	10	55	75	55	65	45	0

Table A	Compounds													
125 g ai/ha	99	100	101	102	103	104	105	106	107	108	109	110	111	112
Preemergence														
Barnyardgrass	0	5	0	0	0	0	0	0	0	10	0	0	0	0
Crabgrass	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Foxtail, Giant	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Morningglory	0	0	0	0	0	0	0	0	0	0	30	0	0	0
Pigweed	0	20	0	10	0	0	0	0	0	55	50	40	0	10
Velvetleaf	0	0	0	10	0	0	0	5	0	10	15	25	0	0

Table A	Compounds													
125 g ai/ha	113	114	115	116	117	118	119	120	121	122	123	127	128	129
Preemergence														
Barnyardgrass	25	0	0	10	25	0	0	5	0	0	0	0	0	0
Crabgrass	15	0	0	0	45	10	0	0	0	0	0	0	0	0
Foxtail, Giant	15	0	0	0	50	0	0	0	0	0	0	0	0	0
Morningglory	90	0	25	30	10	0	0	0	0	0	0	0	0	0
Pigweed	80	0	30	30	65	10	0	0	0	0	0	0	0	0
Velvetleaf	65	0	5	0	55	0	0	0	0	0	0	0	0	0

Table A	Compounds													
125 g ai/ha	130	131	132	133	134	135	136	137	138	139	140	141	142	143
Preemergence														
Barnyardgrass	0	0	0	0	0	65	5	0	0	75	70	35	50	65
Crabgrass	0	0	0	0	0	75	20	0	0	75	70	60	45	70
Foxtail, Giant	0	0	0	0	0	30	10	0	0	80	40	5	25	35
Morningglory	0	0	0	0	0	95	10	0	0	90	90	85	85	90
Pigweed	0	0	15	10	0	85	45	0	0	90	90	80	70	65
Velvetleaf	0	0	0	10	0	80	30	0	0	90	90	80	85	90

Table A	Compounds						
125 g ai/ha	144	145	146	147	148	149	150
Preemergence							
Barnyardgrass	65	30	65	70	65	70	65
Crabgrass	75	65	35	70	45	20	50
Foxtail, Giant	35	0	60	40	40	35	50
Morningglory	85	75	95	95	90	85	90
Pigweed	75	65	75	80	80	70	70
Velvetleaf	75	70	85	75	80	70	75

TEST B

Seeds selected from barnyardgrass (*Echinochloa crus-galli*), Surinam grass (*Brachiaria decumbens*), cocklebur (*Xanthium strumarium*), corn (*Zea mays*), crabgrass (*Digitaria sanguinalis*), giant foxtail (*Setaria faberii*), lambsquarters (*Chenopodium album*), morningglory (*Ipomoea coccinea*), pigweed (*Amaranthus retroflexus*), velvetleaf (*Abutilon theophrasti*), and wheat (*Triticum aestivum*) were planted and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant.

At the same time, plants selected from these crop and weed species and also blackgrass (*Alopecurus myosuroides*) and wild oat (*Avena fatua*) were treated with postemergence applications of test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage) for postemergence treatments. Plant species in the flooded paddy test consisted of rice (*Oryza sativa*), umbrella sedge (*Cyperus difformis*), duck salad (*Heteranthera limosa*) and barnyardgrass (*Echinochloa crus-galli*) grown to the 2-leaf stage for testing. Treated plants and controls were maintained in a greenhouse for 13 to 15 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table B, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

Table B	Compounds													
1000 g ai/ha	1	2	3	4	5	7	8	9	10	11	12	13	14	15
Flood														
Barnyardgrass	80	90	0	90	50	20	70	90	0	0	0	0	80	90
Ducksalad	80	90	0	100	90	0	90	100	0	70	20	0	80	80
Rice	70	60	0	80	0	0	60	80	0	0	20	0	20	70
Sedge, Umbrella	20	90	0	80	90	0	40	90	0	20	0	0	50	70

Table B	Compounds													
1000 g ai/ha	16	17	18	19	21	22	23	24	25	26	27	28	30	31
Flood														
Barnyardgrass	90	80	0	80	60	80	0	0	30	60	0	0	0	30
Ducksalad	90	90	80	80	80	90	30	0	40	90	60	30	0	60
Rice	70	50	0	60	40	60	0	10	30	70	20	0	0	20
Sedge, Umbrella	60	50	0	70	0	50	0	20	40	80	60	0	0	0

Table B	Compounds													
1000 g ai/ha	32	33	34	35	36	37	38	39	40	41	42	44	45	46
Flood														
Barnyardgrass	0	0	0	0	0	20	0	0	70	0	0	0	0	0
Ducksalad	0	0	0	0	0	100	0	0	80	90	0	90	0	60
Rice	0	0	0	0	0	0	0	0	60	0	0	0	0	0

Sedge, Umbrella	0	0	0	0	0	90	0	0	70	80	0	80	0	30

Table B	Compounds					
1000 g ai/ha	47	48	49	50	51	124
Flood						
Barnyardgrass	0	20	50	30	0	0
Ducksalad	80	20	60	40	0	0
Rice	0	0	30	30	0	0
Sedge, Umbrella	70	0	70	0	0	0

Table B	Compounds													
500 g ai/ha	58	59	60	64	75	76	77	78	79	80	83	88	91	92
Flood														
Barnyardgrass	0	0	20	0	70	70	60	40	0	50	0	0	20	0
Ducksalad	100	0	90	100	70	70	80	70	70	70	100	90	100	90
Rice	0	0	0	0	70	50	50	40	20	50	0	0	0	0
Sedge, Umbrella	100	0	30	90	10	70	40	50	0	70	100	90	90	90

Table B	Compounds									
500 g ai/ha	94	95	96	113	117	128	129	133	135	136
Flood										
Barnyardgrass	0	30	10	0	70	30	20	0	80	20
Ducksalad	100	100	100	0	100	100	100	90	90	90
Rice	0	40	0	0	50	0	0	0	60	40
Sedge, Umbrella	90	90	90	0	90	100	100	90	80	90

Table B	Compound
250 g ai/ha	64
Flood	
Barnyardgrass	0
Ducksalad	100
Rice	0
Sedge, Umbrella	70

Table B	Compounds													
125 g ai/ha	58	59	60	64	75	76	77	78	79	80	83	88	91	92
Flood														
Barnyardgrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	100	0	80	90	0	0	40	20	10	50	100	90	100	80
Rice	0	0	0	0	0	0	0	20	0	0	0	0	0	0
Sedge, Umbrella	90	0	0	0	0	30	0	10	0	20	90	60	80	80

Table B	Compounds									
125 g ai/ha	94	95	96	113	117	128	129	133	135	136
Flood										
Barnyardgrass	0	0	0	0	20	0	0	0	30	0
Ducksalad	100	90	100	0	100	90	100	90	60	90
Rice	0	0	0	0	20	0	0	0	20	0
Sedge, Umbrella	90	90	90	0	80	90	90	90	70	90

Table B	Compound
62 g ai/ha	64
Flood	
Barnyardgrass	0
Ducksalad	80
Rice	0
Sedge, Umbrella	0

Table B	Compounds													
500 g ai/ha	2	3	5	7	8	9	10	11	12	13	14	15	16	17
Postemergence														
Barnyardgrass	90	10	90	30	90	90	10	90	40	10	90	90	90	90
Blackgrass	80	50	80	80	0	80	0	60	0	20	60	80	70	70
Cocklebur	100	100	100	100	100	100	70	90	70	40	70	100	100	100
Corn	80	0	90	30	90	90	0	0	0	0	70	80	80	80
Crabgrass	90	40	90	30	90	90	40	70	30	30	30	60	80	50
Foxtail, Giant	80	40	50	40	90	90	10	50	30	20	50	70	80	70
Lambsquarters	100	100	100	100	100	100	90	100	80	70	100	100	100	100
Morningglory	100	100	100	90	100	100	80	100	80	70	100	100	100	100
Oat, Wild	70	30	60	70	0	70	10	10	0	0	70	70	60	50
Pigweed	100	90	100	90	100	100	90	90	80	70	90	100	100	90
Surinam Grass	90	30	80	20	90	90	10	50	0	0	50	90	90	80
Velvetleaf	100	80	90	90	100	100	80	80	60	50	70	90	90	100
Wheat	70	20	60	80	0	70	0	40	0	0	50	70	60	60

Table B	Compounds													
500 g ai/ha	18	19	21	22	23	24	25	26	27	28	30	31	32	33
Postemergence														
Barnyardgrass	0	90	0	90	0	10	80	60	0	50	80	0	70	20
Blackgrass	0	80	20	80	10	10	60	70	30	30	70	0	40	40
Cocklebur	70	100	10	100	90	70	90	90	100	100	100	80	90	80
Corn	0	70	0	80	0	10	30	20	20	0	30	0	10	0

Crabgrass	0	80	0	90	0	40	80	70	10	50	90	30	20	20
Foxtail, Giant	0	80	0	80	10	30	80	40	30	40	90	0	20	40
Lambsquarters	90	100	20	100	80	80	90	80	90	90	100	70	80	70
Morningglory	70	100	30	100	70	90	90	80	90	90	100	70	90	70
Oat, Wild	0	70	0	60	10	0	20	40	30	10	70	0	30	20
Pigweed	70	100	30	100	70	80	100	80	70	90	100	50	80	80
Surinam Grass	0	90	0	90	10	10	70	60	0	50	80	0	10	0
Velvetleaf	50	100	30	100	70	50	70	70	70	90	90	60	50	50
Wheat	0	60	20	70	20	0	30	30	30	10	60	0	30	20

Table B	Compounds													
500 g ai/ha	34	35	36	37	38	39	40	41	42	44	46	47	48	49
Postemergence														
Barnyardgrass	60	90	0	90	0	70	90	70	30	50	30	60	20	70
Blackgrass	70	70	40	60	0	0	60	60	60	40	10	0	20	50
Cocklebur	80	100	70	100	0	50	90	–	90	100	0	100	80	100
Corn	0	60	0	70	0	50	60	80	0	70	0	0	0	30
Crabgrass	30	50	0	80	20	40	80	20	30	80	30	60	20	80
Foxtail, Giant	50	60	10	60	0	30	60	30	0	–	10	50	10	70
Lambsquarters	90	100	50	100	60	90	100	90	90	90	30	90	80	90
Morningglory	70	100	70	100	40	100	100	90	90	100	90	90	80	100
Oat, Wild	40	60	40	0	0	0	60	0	0	0	0	0	20	60
Pigweed	80	100	30	100	30	70	100	90	90	90	80	80	80	90
Surinam Grass	50	80	0	70	20	30	70	10	10	50	10	20	10	60
Velvetleaf	60	90	40	100	50	70	90	70	80	90	0	40	60	80
Wheat	40	60	40	60	0	0	60	40	50	30	0	0	20	40

Table B	Compounds								
500 g ai/ha	50	51	52	54	55	56	124	125	126
Postemergence									
Barnyardgrass	50	60	80	70	50	30	40	70	0
Blackgrass	50	30	50	40	40	20	40	20	0
Cocklebur	90	90	60	80	80	20	80	60	0
Corn	40	0	60	20	20	0	0	0	10
Crabgrass	80	60	60	30	30	0	40	30	20
Foxtail, Giant	70	30	60	30	20	0	20	40	0
Lambsquarters	90	90	90	90	90	30	90	70	40
Morningglory	90	90	90	90	90	50	100	90	60
Oat, Wild	60	30	20	40	20	20	30	20	20

Pigweed	90	90	90	90	80	70	90	60	30
Surinam Grass	60	40	30	0	0	0	0	10	70
Velvetleaf	90	80	50	60	30	0	50	50	20
Wheat	60	40	20	20	0	0	30	0	0

Table B	Compounds			
250 g ai/ha	1	4	45	53
Postemergence				
Barnyardgrass	90	90	0	90
Blackgrass	70	90	0	60
Cocklebur	90	100	10	90
Corn	70	90	0	70
Crabgrass	90	90	20	30
Foxtail, Giant	80	90	0	70
Lambsquarters	100	100	30	100

Table B	Compounds			
250 g ai/ha	1	4	45	53
Postemergence				
Morningglory	100	100	60	90
Oat, Wild	60	80	0	60
Pigweed	100	100	50	100
Surinam Grass	90	90	0	50
Velvetleaf	90	100	20	80
Wheat	70	80	0	60

Table B	Compounds													
125 g ai/ha	2	3	5	7	8	9	10	11	12	13	14	15	16	17
Postemergence														
Barnyardgrass	90	0	50	0	90	90	0	20	0	0	30	90	70	20
Blackgrass	50	20	70	60	0	60	0	20	0	10	30	70	10	0
Cocklebur	100	70	80	90	100	100	60	80	40	10	50	100	90	100
Corn	20	0	30	0	70	70	0	0	0	0	30	50	30	0
Crabgrass	90	30	50	10	80	90	30	30	10	20	10	30	30	20
Foxtail, Giant	70	20	40	20	80	90	0	10	0	10	20	40	30	10
Lambsquarters	100	100	100	80	100	90	80	90	60	60	100	100	100	100
Morningglory	100	80	100	80	100	100	80	80	60	50	100	100	100	100
Oat, Wild	40	10	40	40	0	20	0	0	0	0	20	10	10	0
Pigweed	100	80	90	0	100	100	80	80	50	50	80	80	90	70
Surinam Grass	90	10	50	0	80	90	10	20	0	0	10	60	60	30
Velvetleaf	60	50	70	50	80	100	50	60	20	40	50	80	80	60
Wheat	40	10	50	50	0	40	0	0	0	0	20	40	30	0

Table B	Compounds													
125 g ai/ha	18	19	21	22	23	24	25	26	27	28	30	32	33	34
Postemergence														
Barnyardgrass	0	80	0	70	0	0	40	20	0	20	0	20	0	0
Blackgrass	0	60	10	60	0	0	10	40	30	10	60	30	40	60
Cocklebur	70	90	0	100	30	50	90	80	100	90	100	40	60	80
Corn	0	30	0	20	0	0	0	0	0	0	0	0	0	0

Crabgrass	0	40	0	50	0	20	60	40	10	30	30	10	10	0
Foxtail, Giant	0	20	0	70	0	20	50	30	20	20	0	10	10	20
Lambsquarters	70	100	10	100	70	70	90	70	80	90	90	70	60	70
Morningglory	20	100	10	90	40	60	90	70	70	90	90	40	40	60
Oat, Wild	0	40	0	10	10	0	10	30	20	0	60	20	20	30
Pigweed	20	90	0	100	30	70	90	70	60	80	90	80	60	50
Surinam Grass	0	40	0	80	0	0	50	30	0	10	10	0	0	10
Velvetleaf	20	70	10	100	40	40	60	40	60	70	50	10	40	30
Wheat	0	20	10	0	0	0	20	30	20	0	50	20	20	30

Table B						Compounds								
125 g ai/ha	35	36	37	38	39	40	41	42	44	46	47	48	49	50
Postemergence														
Barnyardgrass	40	0	0	0	0	0	20	10	40	0	20	10	30	10
Blackgrass	60	0	40	0	0	50	20	30	30	0	0	0	20	30
Cocklebur	30	20	100	0	30	0	70	80	90	0	90	20	90	90
Corn	0	0	0	0	0	0	20	0	30	0	0	0	0	0
Crabgrass	20	0	60	0	0	0	10	0	70	10	10	10	30	40
Foxtail, Giant	10	0	10	0	0	0	20	0	–	0	10	10	10	20
Lambsquarters	90	40	100	20	70	0	80	80	90	10	80	60	80	80
Morningglory	70	10	90	10	80	0	70	80	80	80	80	30	90	90
Oat, Wild	60	0	0	0	0	40	0	0	0	0	0	0	30	30
Pigweed	70	20	100	30	50	0	70	80	80	70	70	60	90	80
Surinam Grass	20	0	20	0	0	0	0	0	–	0	0	0	10	20
Velvetleaf	50	20	80	0	40	0	50	50	80	0	20	10	50	70
Wheat	20	0	0	0	0	50	30	50	0	0	0	0	30	30

Table B						Compounds								
125 g ai/ha	51	52	54	55	56	75	76	77	78	79	83	88	92	94
Postemergence														
Barnyardgrass	20	30	0	0	0	90	90	90	90	80	80	90	10	90
Blackgrass	20	0	40	30	0	60	60	60	40	50	60	60	20	60
Cocklebur	80	40	20	20	0	100	90	100	100	60	100	100	80	100
Corn	0	0	0	0	0	70	70	80	80	60	10	80	0	90
Crabgrass	30	0	20	0	0	80	90	80	70	60	60	80	20	80
Foxtail, Giant	0	40	20	20	0	80	80	80	70	70	50	70	30	60
Lambsquarters	80	80	80	70	20	100	100	100	100	100	100	100	90	90
Morningglory	80	90	80	80	0	100	100	100	100	100	100	90	60	90
Oat, Wild	20	0	0	0	0	60	60	60	70	40	40	50	0	30
Pigweed	80	60	80	70	50	90	100	100	100	100	100	100	80	90

Surinam Grass	0	0	0	0	0	80	80	80	80	60	60	80	10	80
Velvetleaf	70	40	50	10	0	100	90	90	80	80	90	100	60	100
Wheat	30	0	0	0	0	70	70	60	70	40	30	60	0	60

Table B	Compounds										
125 g ai/ha	95	113	117	124	125	126	128	129	133	135	136
Postemergence											
Barnyardgrass	90	80	90	0	0	0	60	70	70	90	90
Blackgrass	–	40	70	0	0	0	50	70	70	70	70
Cocklebur	90	90	100	30	40	0	90	100	100	100	100
Corn	90	40	90	0	0	0	70	80	80	80	70
Crabgrass	80	40	80	10	20	0	40	70	70	70	80
Foxtail, Giant	80	50	80	10	0	0	50	50	70	80	70
Lambsquarters	100	90	100	40	60	30	90	100	100	100	100
Morningglory	100	90	100	50	70	30	90	100	100	100	100
Oat, Wild	60	50	50	0	0	0	40	40	60	60	50
Pigweed	100	90	100	50	60	0	90	100	100	100	100
Surinam Grass	90	80	70	0	0	0	40	70	70	80	80
Velvetleaf	100	80	100	20	0	10	80	90	100	100	90
Wheat	50	50	70	0	0	0	20	20	50	60	60

Table B	Compounds													
62 g ai/ha	1	4	31	45	53	65	75	76	77	78	79	83	88	92
Postemergence														
Barnyardgrass	50	70	0	0	80	70	80	90	60	80	50	50	90	10
Blackgrass	40	70	0	0	20	70	50	50	50	20	20	50	40	20
Cocklebur	90	90	70	0	50	100	70	60	70	100	–	90	100	60
Corn	30	50	0	0	0	80	60	50	30	40	20	10	70	0
Crabgrass	70	80	0	0	0	80	70	70	70	60	30	50	70	0
Foxtail, Giant	50	80	0	0	30	70	60	60	70	60	40	40	60	20
Lambsquarters	100	100	40	10	90	100	90	100	100	100	90	100	100	90
Morningglory	90	90	50	40	90	80	100	100	100	100	90	60	60	50
Oat, Wild	20	50	0	0	30	40	50	50	50	50	30	0	40	0
Pigweed	90	100	20	30	80	100	80	90	90	80	80	100	100	70
Surinam Grass	60	90	0	0	10	80	70	70	70	60	20	50	80	0
Velvetleaf	90	70	10	0	40	90	70	90	80	70	50	80	90	50
Wheat	30	40	0	0	30	50	50	60	50	50	0	0	50	0

Table B	Compounds								
62 g ai/ha	94	95	113	117	128	129	133	135	136
Postemergence									
Barnyardgrass	80	90	50	90	40	60	70	70	70
Blackgrass	40	60	30	60	40	70	60	60	70
Cocklebur	100	90	90	100	70	70	100	100	90
Corn	70	80	10	90	10	70	70	50	40
Crabgrass	70	80	20	60	20	50	60	60	70
Foxtail, Giant	50	80	20	80	30	40	60	80	60
Lambsquarters	90	100	80	90	90	100	100	100	100
Morningglory	80	90	90	80	40	50	70	100	40
Oat, Wild	30	30	40	30	0	0	40	60	20
Pigweed	90	100	70	100	90	100	90	100	90
Surinam Grass	80	80	30	70	30	50	60	80	70
Velvetleaf	90	100	60	90	50	80	90	100	80
Wheat	40	40	30	50	0	0	0	40	20

Table B	Compound
4 g ai/ha	65
Postemergence	
Barnyardgrass	20
Blackgrass	20
Cocklebur	80
Corn	10
Crabgrass	20

Table B	Compound
4 g ai/ha	65
Postemergence	
Foxtail, Giant	40
Lambsquarters	80
Morningglory	70
Oat, Wild	0
Pigweed	70

Table B	Compound
4 g ai/ha	65
Postemergence	
Surinam Grass	20
Velvetleaf	50
Wheat	0

Table B	Compounds													
500 g ai/ha	2	3	5	7	8	9	10	11	12	13	14	15	16	17
Preemergence														
Barnyardgrass	90	0	30	30	90	90	50	10	80	80	80	90	90	80
Cocklebur	100	80	80	80	100	100	90	90	90	100	80	100	100	90
Corn	80	0	70	0	90	80	0	0	30	30	70	80	70	60
Crabgrass	90	50	70	30	90	100	60	80	70	70	80	90	100	100
Foxtail, Giant	90	0	10	0	90	80	20	70	50	40	80	80	80	70
Lambsquarters	100	90	100	90	100	100	90	100	100	100	100	100	100	100
Morningglory	100	60	80	80	100	100	90	90	90	100	100	100	100	100
Pigweed	100	90	90	90	100	100	90	90	90	90	90	100	90	100
Surinam Grass	90	20	10	0	90	90	0	70	–	–	80	90	80	90
Velvetleaf	100	70	90	80	100	100	90	90	90	90	80	100	100	90

Wheat	70	0	50	30	80	80	0	50	60	60	50	60	60	60

Table B	Compounds													
500 g ai/ha	18	19	21	22	23	24	25	26	27	28	30	31	32	33
Preemergence														
Barnyardgrass	0	90	10	20	0	20	60	90	60	30	40	70	10	50
Cocklebur	40	100	80	80	10	90	90	90	90	90	100	100	90	90
Corn	0	90	–	–	0	0	0	80	50	0	80	40	0	30
Crabgrass	0	90	60	100	0	80	70	90	70	80	90	80	40	50
Foxtail, Giant	0	80	10	20	0	60	80	80	40	50	80	80	0	40
Lambsquarters	60	100	80	100	30	90	90	100	100	100	90	100	90	100
Morningglory	0	100	90	100	10	90	90	100	90	90	100	100	80	90
Pigweed	70	100	70	80	20	90	90	100	100	90	90	100	90	90
Surinam Grass	0	90	20	20	0	50	70	80	70	60	80	60	0	40
Velvetleaf	40	100	80	100	20	80	80	100	90	90	80	90	80	80
Wheat	0	60	30	50	0	70	60	60	50	40	60	70	10	50

Table B	Compounds													
500 g ai/ha	34	35	36	37	38	39	40	41	42	44	46	47	48	49
Preemergence														
Barnyardgrass	0	80	0	40	0	20	90	10	0	10	0	40	10	60
Cocklebur	60	90	60	80	0	30	100	10	70	80	40	90	20	90
Corn	0	50	0	10	10	50	50	0	0	0	0	30	0	40
Crabgrass	70	80	0	90	0	50	80	20	20	80	40	90	–	90
Foxtail, Giant	20	70	0	60	0	20	80	0	0	40	50	40	50	70
Lambsquarters	80	100	40	100	90	100	100	60	90	60	60	100	100	100
Morningglory	70	100	0	50	50	70	100	20	80	40	90	100	30	100
Pigweed	80	100	20	100	70	100	100	60	90	80	90	90	80	100
Surinam Grass	50	60	0	40	0	0	70	0	20	60	40	20	60	60
Velvetleaf	60	90	40	80	0	30	90	30	70	80	20	90	0	90
Wheat	10	50	0	60	0	10	70	20	10	60	20	50	30	70

Table B	Compounds								
500 g ai/ha	50	51	52	54	55	56	124	125	126
Preemergence									
Barnyardgrass	50	0	30	40	60	0	0	–	0
Cocklebur	90	20	60	90	90	30	60	90	90
Corn	20	0	0	0	0	0	0	0	0
Crabgrass	80	0	0	0	60	0	0	100	100
Foxtail, Giant	40	0	0	0	0	0	0	0	0

Lambsquarters	100	80	-	-	-	-	70	-	-
Morningglory	90	40	100	-	100	20	60	100	70
Pigweed	90	70	50	100	100	80	70	90	80
Surinam Grass	70	0	0	0	50	0	0	0	20
Velvetleaf	90	0	30	80	90	30	50	90	20
Wheat	40	0	0	0	70	0	0	0	0

Table B	Compounds			
250 g ai/ha	1	4	45	53
Preemergence				
Barnyardgrass	90	90	0	70
Cocklebur	100	100	0	100
Corn	80	80	-	0
Crabgrass	90	90	0	50
Foxtail, Giant	90	80	0	50
Lambsquarters	100	100	30	-

Table B	Compounds			
250 g ai/ha	1	4	45	53
Preemergence				
Morningglory	100	100	50	100
Pigweed	100	100	50	100
Surinam Grass	80	90	0	30
Velvetleaf	100	90	0	90
Wheat	60	70	0	40

Table B	Compounds													
125 g ai/ha	2	3	5	7	8	9	10	11	12	13	14	15	16	17
Preemergence														
Barnyardgrass	70	0	10	0	70	50	20	0	50	40	10	40	30	20
Cocklebur	90	80	70	70	90	90	80	80	80	90	60	70	70	80
Corn	0	0	0	0	90	50	0	0	0	-	0	20	30	0
Crabgrass	90	10	20	0	80	90	20	30	20	50	10	70	70	70
Foxtail, Giant	30	0	0	0	50	70	0	10	20	20	30	40	30	20
Lambsquarters	100	70	90	80	90	90	-	100	90	90	90	90	100	90
Morningglory	100	50	70	70	100	100	80	80	70	90	70	70	90	100
Pigweed	90	80	90	90	100	90	80	80	80	80	80	90	90	80
Surinam Grass	40	0	0	0	60	70	0	10	0	0	40	30	40	30
Velvetleaf	90	40	70	50	80	90	80	80	80	80	60	70	80	70
Wheat	60	0	-	0	60	40	0	0	30	40	40	40	50	40

Table B	Compounds													
125 g ai/ha	18	19	21	22	23	24	25	26	27	28	30	32	33	34
Preemergence														
Barnyardgrass	0	40	0	0	0	0	20	50	30	10	10	0	20	0
Cocklebur	10	90	30	50	0	80	80	80	80	80	60	80	80	30
Corn	0	70	0	10	0	-	0	30	10	0	10	0	10	0
Crabgrass	0	80	0	20	0	60	60	30	30	70	50	0	0	0
Foxtail, Giant	0	20	0	0	0	10	40	10	0	30	10	0	0	0

Lambsquarters	10	100	70	70	0	70	90	100	90	80	80	40	90	50
Morningglory	0	90	50	100	0	50	80	90	80	80	90	40	0	20
Pigweed	0	90	50	60	0	80	80	90	90	80	50	40	80	40
Surinam Grass	0	60	0	0	0	10	20	10	0	–	0	0	0	10
Velvetleaf	0	90	10	30	0	50	70	90	80	80	10	50	70	30
Wheat	0	50	0	10	0	30	50	30	10	10	30	0	0	0

Table B	Compounds													
125 g ai/ha	35	36	37	38	39	40	41	42	44	46	47	48	49	50
Preemergence														
Barnyardgrass	10	0	10	0	0	50	0	0	0	0	0	0	30	30
Cocklebur	60	10	20	0	10	90	0	40	10	0	80	0	80	80
Corn	0	0	0	0	30	0	0	0	0	0	0	0	10	20
Crabgrass	30	0	50	0	0	60	0	0	40	0	20	10	80	50
Foxtail, Giant	0	0	10	0	0	20	0	0	20	0	20	30	40	10
Lambsquarters	90	0	100	20	50	100	30	40	–	10	90	70	90	90
Morningglory	70	0	10	0	30	90	0	20	10	50	80	0	80	80
Pigweed	80	0	100	10	70	90	0	50	70	80	80	60	90	70
Surinam Grass	10	0	–	0	0	50	–	0	40	0	0	30	40	20
Velvetleaf	70	10	40	0	0	90	10	10	30	0	60	0	80	80
Wheat	20	0	30	0	0	40	0	10	30	0	20	0	30	20

Table B	Compounds													
125 g ai/ha	51	52	54	55	56	75	76	77	78	79	83	88	92	94
Preemergence														
Barnyardgrass	0	0	0	0	0	80	90	90	70	70	30	–	30	–
Cocklebur	0	10	50	70	0	90	100	100	100	80	50	90	50	50
Corn	0	–	0	0	0	80	80	80	70	60	0	10	0	0
Crabgrass	0	0	0	50	0	90	90	90	90	70	60	70	10	70
Foxtail, Giant	0	0	0	0	0	90	80	90	70	20	10	30	10	20
Lambsquarters	–	–	–	–	–	100	100	100	100	90	90	–	80	–
Morningglory	0	10	0	80	–	100	100	100	100	90	10	10	0	0
Pigweed	10	–	100	80	–	100	100	100	100	100	100	–	80	–
Surinam Grass	0	0	0	0	0	80	90	90	90	0	10	50	0	30
Velvetleaf	0	0	10	50	0	100	90	100	90	80	60	90	70	70
Wheat	0	0	0	0	0	70	70	70	70	60	50	70	30	60

Table B	Compounds										
125 g ai/ha	95	113	117	124	125	126	128	129	133	135	136
Preemergence											
Barnyardgrass	-	20	30	0	0	0	10	30	30	90	80
Cocklebur	100	80	90	10	30	0	10	30	50	100	70
Corn	80	20	10	0	0	0	0	0	0	80	0
Crabgrass	100	70	90	0	0	80	0	30	70	90	80
Foxtail, Giant	90	10	90	0	0	0	0	0	20	90	50
Lambsquarters	-	80	100	0	-	-	50	80	70	100	100
Morningglory	60	60	20	10	30	0	0	0	0	100	40
Pigweed	-	90	100	20	30	20	50	90	80	100	100
Surinam Grass	100	60	100	0	0	0	0	10	10	90	50
Velvetleaf	100	90	90	20	10	10	40	60	60	100	80
Wheat	80	60	80	0	0	0	0	20	60	90	70

Table B	Compounds													
62 g ai/ha	1	4	31	45	53	65	75	76	77	78	79	83	88	92
Preemergence														
Barnyardgrass	60	30	20	0	0	40	60	40	70	60	0	20	-	10
Cocklebur	90	80	90	-	60	80	90	80	80	80	50	10	60	40
Corn	20	0	0	0	0	0	50	70	70	30	30	0	0	0
Crabgrass	90	70	10	0	0	70	80	80	80	80	0	30	50	0
Foxtail, Giant	30	10	10	0	0	30	30	40	70	20	0	0	10	0
Lambsquarters	100	90	90	0	-	90	100	90	100	90	90	70	-	50
Morningglory	90	60	90	30	90	30	80	100	100	80	70	0	0	0
Pigweed	90	90	90	0	60	100	100	100	100	100	80	80	-	40
Surinam Grass	50	40	20	0	0	40	70	70	60	60	0	0	20	0
Velvetleaf	90	80	80	0	20	70	80	80	80	70	50	50	70	50
Wheat	30	50	40	0	0	80	30	30	70	30	0	20	50	0

Table B	Compounds								
62 g ai/ha	94	95	113	117	128	129	133	135	136
Preemergence									
Barnyardgrass	-	-	0	10	0	10	30	70	30
Cocklebur	30	90	70	50	0	10	20	100	40
Corn	0	40	0	0	0	-	0	50	0
Crabgrass	40	80	40	90	0	10	40	80	70
Foxtail, Giant	0	50	0	20	0	0	0	60	10
Lambsquarters	-	-	70	90	10	-	-	100	90

Morningglory	0	30	50	10	0	0	0	100	10
Pigweed	–	–	70	100	10	80	70	100	80
Surinam Grass	10	50	20	80	0	0	0	80	10
Velvetleaf	40	80	80	70	0	50	50	90	60
Wheat	30	70	10	50	0	0	50	70	50

Table B	Compound	Table B	Compound	Table B	Compound
4 g ai/ha	65	4 g ai/ha	65	4 g ai/ha	65
Preemergence		Preemergence		Preemergence	
Barnyardgrass	0	Foxtail, Giant	0	Surinam Grass	0
Cocklebur	10	Lambsquarters	30	Velvetleaf	0
Corn	0	Morningglory	0	Wheat	20
Crabgrass	20	Pigweed	20		

TEST C

Seeds or nutlets of plant species selected from bermudagrass (*Cynodon dactylon*), Surinam grass (*Brachiaria decumbens*), cocklebur (*Xanthium strumarium*), corn (*Zea mays*), crabgrass (*Digitaria sanguinalis*), woolly cupgrass (*Eriochloa villosa*), giant foxtail (*Setaria faberii*), goosegrass (*Eleusine indica*), johnsongrass (*Sorghum halepense*), kochia (*Kochia scoparia*), lambsquarters (*Chenopodium album*), morningglory (*Ipomoea coccinea*), eastern black nightshade (*Solanum ptycanthum*), yellow nutsedge (*Cyperus esculentus*), pigweed (*Amaranthus retroflexus*), common ragweed (*Ambrosia elatior*), soybean (*Glycine max*), common (oilseed) sunflower (*Helianthus annuus*), and velvetleaf (*Abutilon theophrasti*) were planted and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant.

At the same time, plants selected from these crop and weed species and also winter barley (*Hordeum vulgare*), blackgrass (*Alopecurus myosuroides*), canarygrass (*Phalaris minor*), chickweed (*Stellaria media*), downy brome (*Bromus tectorum*), green foxtail (*Setaria viridis*), Italian ryegrass (*Lolium multiflorum*), wheat (*Triticum aestivum*), wild oat (*Avena fatua*) and windgrass (*Apera spica-venti*) were treated with postemergence applications of some of the test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage) for postemergence treatments. Plant species in the flooded paddy test consisted of rice (*Oryza sativa*), umbrella sedge (*Cyperus difformis*), duck salad (*Heteranthera limosa*) and barnyardgrass (*Echinochloa crus-galli*) grown to the 2-leaf stage for testing. Treated plants and controls were maintained in a greenhouse for 12 to 14 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table C, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

Table C	Compounds												
500 g ai/ha	1	2	4	5	9	14	15	16	17	19	22	26	37
Flood													
Barnyardgrass	25	75	85	20	85	45	75	50	50	60	70	0	0
Ducksalad	0	95	100	0	90	55	85	85	80	60	95	40	100
Rice	0	65	80	0	75	0	50	65	75	20	60	25	0
Sedge, Umbrella	0	25	75	0	85	30	25	55	25	50	95	20	95

Table C	Compounds												
250 g ai/ha	1	2	4	5	9	14	15	16	17	19	22	26	37
Flood													
Barnyardgrass	15	45	65	0	55	0	25	15	0	0	40	0	0
Ducksalad	0	90	90	0	80	45	50	75	80	60	90	40	100
Rice	0	45	75	0	55	0	20	0	45	10	40	20	0
Sedge, Umbrella	0	0	65	0	15	0	10	50	20	50	75	20	90

Table C	Compounds												
125 g ai/ha	1	2	4	5	9	14	15	16	17	19	22	26	37
Flood													
Barnyardgrass	0	20	60	0	15	0	0	0	0	0	0	0	0
Ducksalad	–	70	80	0	70	40	45	65	0	40	60	40	95
Rice	0	25	40	0	30	0	0	0	0	0	20	0	0
Sedge, Umbrella	–	0	30	0	15	0	0	0	0	50	30	0	85

Table C	Compounds												
62 g ai/ha	1	2	4	5	9	14	15	16	17	19	22	26	37
Flood													
Barnyardgrass	0	0	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	0	50	70	0	45	0	45	65	0	20	30	40	95
Rice	0	0	0	0	0	0	0	0	0	0	20	0	0
Sedge, Umbrella	0	0	0	0	0	0	0	–	0	20	0	0	85

Table C	Compounds													
500 g ai/ha	1	4	5	7	8	10	15	22	27	28	35	37	49	50
Postemergence														
Barley	–	65	–	–	–	–	–	–	–	–	45	–	40	–
Bermudagrass	90	80	80	0	75	0	75	60	30	0	–	20	65	95
Blackgrass	–	70	–	–	–	–	–	–	–	–	65	–	60	–
Bromegrass, Downy	–	70	–	–	–	–	–	–	–	–	40	–	30	–
Canarygrass	–	60	–	–	–	–	–	–	–	–	55	–	40	–

Chickweed	–	100	–	0	100	70	85	90	0	20	–	0	45	20
Cocklebur	100	100	100	30	100	75	100	100	25	100	–	95	95	90
Corn	45	95	45	0	90	0	75	65	0	0	–	25	25	65
Crabgrass	90	80	80	25	75	0	80	85	30	20	–	60	95	80
Cupgrass, Woolly	90	95	70	20	85	0	75	65	0	0	–	45	65	30
Foxtail, Giant	90	95	60	10	75	0	70	60	0	15	–	45	0	20
Foxtail, Green	–	75	–	–	–	–	–	–	–	–	65	–	60	–
Goosegrass	70	75	50	0	60	0	55	25	0	15	–	0	25	0
Johnsongrass	70	95	45	0	85	0	80	100	0	0	–	55	70	60
Kochia	100	100	100	80	100	100	100	100	60	95	–	95	100	95
Lambsquarters	100	100	100	80	100	100	100	95	50	95	–	95	95	85
Morningglory	100	100	100	65	100	95	100	100	85	95	–	95	100	95
Nutsedge, Yellow	5	0	0	0	0	0	0	0	0	0	–	20	0	0
Oat, Wild	–	70	–	–	–	–	–	–	–	–	55	–	60	–
Pigweed	100	100	100	55	100	95	100	100	80	75	–	100	95	95
Ragweed	100	100	100	75	100	90	95	90	50	95	–	95	90	80
Ryegrass, Italian	–	65	–	–	–	–	–	–	–	–	40	–	50	–
Soybean	100	100	100	60	100	100	100	100	95	95	–	100	100	100
Surinam Grass	95	95	70	0	80	0	65	85	0	0	–	0	45	60
Velvetleaf	100	100	95	40	95	90	90	95	30	75	–	95	80	80
Wheat	–	65	–	–	–	–	–	–	–	–	45	–	60	–
Windgrass	–	75	–	–	–	–	–	–	–	–	65	–	60	–

Table C	Compound	Table C	Compound	Table C	Compound
500 g ai/ha	51	500 g ai/ha	51	500 g ai/ha	51
Postemergence		Postemergence		Postemergence	
Bermudagrass	0	Foxtail, Giant	0	Nutsedge, Yellow	0
Chickweed	45	Goosegrass	0	Pigweed	85
Cocklebur	85	Johnsongrass	0	Ragweed	85
Corn	0	Kochia	95	Soybean	95
Crabgrass	45	Lambsquarters	90	Surinam Grass	0
Cupgrass, Woolly	0	Morningglory	100	Velvetleaf	65

Table C	Compounds													
250 g ai/ha	1	2	3	4	5	7	8	9	10	15	16	17	22	27
Postemergence														
Barley	–	60	30	65	–	–	–	–	–	–	–	–	–	–
Bermudagrass	90	80	45	70	70	0	65	80	0	65	75	0	60	0
Blackgrass	–	75	0	70	–	–	–	–	–	–	–	–	–	–

Bromegrass, Downy	–	60	20	65	–	–	–	–	–	–	–	–	–	–
Canarygrass	–	40	10	60	–	–	–	–	–	–	–	–	–	–
Chickweed	90	95	40	100	20	0	95	100	20	65	35	85	85	0
Cocklebur	100	85	90	100	100	30	100	100	60	100	100	100	100	25
Corn	40	30	0	90	40	0	70	95	0	55	55	20	60	0
Crabgrass	85	70	0	75	70	5	70	80	0	65	75	65	85	5
Cupgrass, Woolly	90	75	0	85	50	0	75	85	0	65	65	20	60	0
Foxtail, Giant	80	70	0	85	50	0	70	80	0	65	65	35	50	0
Foxtail, Green	–	70	35	70	–	–	–	–	–	–	–	–	–	–
Goosegrass	40	45	0	65	40	0	45	45	0	40	20	0	20	0
Johnsongrass	70	60	0	95	45	0	45	85	0	70	70	60	80	0
Kochia	100	100	100	100	100	70	100	100	95	100	100	100	100	50
Lambsquarters	100	100	100	100	100	70	100	100	90	100	100	100	95	25
Morningglory	100	100	75	100	100	55	100	100	95	100	100	100	95	85
Nutsedge, Yellow	5	20	0	0	0	0	0	0	0	0	0	0	0	0
Oat, Wild	–	60	40	70	–	–	–	–	–	–	–	–	–	–
Pigweed	100	100	80	100	90	40	100	100	95	85	95	95	100	30
Ragweed	100	95	95	100	95	65	95	100	80	90	95	95	90	40
Ryegrass, Italian	–	60	35	65	–	–	–	–	–	–	–	–	–	–
Soybean	100	100	95	100	100	35	100	100	90	95	100	100	100	85
Surinam Grass	90	70	0	75	30	0	70	80	0	55	55	0	85	0
Velvetleaf	100	100	70	100	90	35	85	95	80	85	90	95	90	0
Wheat	–	65	10	65	–	–	–	–	–	–	–	–	–	–
Windgrass	–	70	30	70	–	–	–	–	–	–	–	–	–	–

Table C	Compounds											
250 g ai/ha	28	30	34	35	37	42	49	50	51	64	78	88
Postemergence												
Barley	–	–	40	40	–	–	30	–	–	100	90	–
Bermudagrass	0	5	–	–	0	5	55	90	0	70	65	80
Blackgrass	–	–	45	60	–	–	50	–	–	50	50	–
Bromegrass, Downy	–	–	35	40	–	–	0	–	–	20	55	–
Canarygrass	–	–	45	45	–	–	30	–	–	10	0	–
Chickweed	15	85	–	–	0	10	40	–	0	55	70	100
Cocklebur	95	100	–	–	95	20	95	65	70	–	100	90
Corn	0	50	–	–	15	0	20	60	0	–	40	30
Crabgrass	0	50	–	–	40	0	75	75	0	90	90	85
Cupgrass, Woolly	0	40	–	–	0	5	60	15	0	–	90	85
Foxtail, Giant	0	40	–	–	40	0	0	0	0	50	70	85

Foxtail, Green	–	–	45	60	–	–	50	–	–	45	75	–
Goosegrass	0	0	–	–	0	0	20	0	0	70	50	80
Johnsongrass	0	40	–	–	–	10	35	–	0	85	40	85
Kochia	95	100	–	–	95	85	95	65	85	90	95	95
Lambsquarters	85	90	–	–	95	25	95	80	85	90	100	100
Morningglory	95	95	–	–	80	85	80	85	85	90	100	85
Nutsedge, Yellow	0	5	–	–	0	0	0	0	0	50	0	75
Oat, Wild	–	–	50	45	–	–	40	–	–	10	60	–
Pigweed	60	90	–	–	100	30	95	85	80	100	100	100
Ragweed	90	90	–	–	90	40	75	45	80	90	100	100
Ryegrass, Italian	–	–	60	40	–	–	50	–	–	45	25	–
Soybean	95	95	–	–	95	70	95	100	95	100	100	100
Surinam Grass	0	35	–	–	0	0	40	0	0	–	90	85
Velvetleaf	70	60	–	–	90	20	75	70	60	95	100	95
Wheat	–	–	35	45	–	–	50	–	–	10	55	–
Windgrass	–	–	60	65	–	–	60	–	–	60	40	–

Table C						Compounds								
125 g ai/ha	1	2	3	4	5	7	8	9	10	11	15	16	17	19
Postemergence														
Barley	–	60	0	65	–	–	–	–	–	–	–	–	–	45
Bermudagrass	90	70	0	65	50	0	60	70	0	0	45	60	0	45
Blackgrass	–	70	0	65	–	–	–	–	–	–	–	–	–	65
Bromegrass, Downy	–	45	20	60	–	–	–	–	–	–	–	–	–	60
Canarygrass	–	40	10	45	–	–	–	–	–	–	–	–	–	65
Chickweed	–	75	0	85	10	0	75	100	0	0	50	20	55	5
Cocklebur	100	85	75	100	95	30	100	100	15	40	100	100	100	90
Corn	15	20	0	80	40	0	20	65	0	0	15	20	0	35
Crabgrass	85	60	0	75	50	0	65	75	0	20	45	45	20	70
Cupgrass, Woolly	80	70	0	70	50	0	60	70	0	0	50	0	0	65
Foxtail, Giant	65	65	0	75	30	0	60	75	0	0	60	55	0	55
Foxtail, Green	–	65	35	70	–	–	–	–	–	–	–	–	–	60
Goosegrass	0	0	0	20	5	0	0	40	0	0	0	0	0	0
Johnsongrass	30	25	0	80	40	0	35	80	0	0	55	60	40	–
Kochia	100	95	90	100	100	65	100	100	90	90	95	100	100	90
Lambsquarters	100	100	90	100	100	60	100	100	80	80	100	100	100	95
Morningglory	100	100	65	100	95	50	95	100	85	0	95	100	100	85
Nutsedge, Yellow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oat, Wild	–	55	40	65	–	–	–	–	–	–	–	–	–	65

Pigweed	100	95	75	100	90	40	75	100	80	90	70	95	75	65
Ragweed	100	90	80	100	95	35	80	95	65	75	85	95	95	80
Ryegrass, Italian	-	60	35	60	-	-	-	-	-	-	-	-	-	70
Soybean	100	100	90	100	100	25	95	100	80	95	95	100	100	75
Surinam Grass	90	65	0	75	20	0	65	75	0	0	20	25	0	-
Velvetleaf	90	80	55	100	90	10	70	80	70	75	70	65	80	60
Wheat	-	65	0	60	-	-	-	-	-	-	-	-	-	45
Windgrass	-	70	30	65	-	-	-	-	-	-	-	-	-	60

Table C						Compounds								
125 g ai/ha	22	25	27	28	30	34	35	37	42	47	49	50	51	64
Postemergence														
Barley	-	-	-	-	-	30	35	-	-	-	20	-	-	-
Bermudagrass	60	0	0	0	5	-	-	0	0	15	55	75	0	65
Blackgrass	-	-	-	-	-	35	50	-	-	-	40	-	-	50
Bromegrass, Downy	-	-	-	-	-	30	30	-	-	-	0	-	-	20
Canarygrass	-	-	-	-	-	35	45	-	-	-	20	-	-	10
Chickweed	60	85	0	0	65	-	-	0	0	0	0	0	0	0
Cocklebur	90	90	25	95	100	-	-	95	5	65	95	40	65	100
Corn	40	0	0	0	0	-	-	10	0	0	0	0	0	50
Crabgrass	55	50	0	0	5	-	-	15	0	20	65	60	0	85
Cupgrass, Woolly	60	30	0	0	0	-	-	0	0	0	15	0	0	65
Foxtail, Giant	45	30	0	0	0	-	-	0	0	0	0	0	0	50
Foxtail, Green	-	-	-	-	-	45	50	-	-	-	20	-	-	40
Goosegrass	10	0	0	0	0	-	-	0	0	0	0	0	0	60
Johnsongrass	80	20	0	0	10	-	-	20	0	0	20	-	-	85
Kochia	100	85	20	85	100	-	-	90	50	100	45	55	60	90
Lambsquarters	95	90	20	75	80	-	-	95	20	80	90	75	75	90
Morningglory	90	90	85	95	95	-	-	65	80	65	70	80	80	90
Nutsedge, Yellow	0	0	0	0	0	-	-	0	0	0	0	0	0	50
Oat, Wild	-	-	-	-	-	45	45	-	-	-	40	-	-	10
Pigweed	100	100	20	35	80	-	-	95	20	70	80	80	70	100
Ragweed	85	70	20	80	85	-	-	80	40	80	65	45	80	85
Ryegrass, Italian	-	-	-	-	-	45	40	-	-	-	30	-	-	35
Soybean	100	90	45	85	90	-	-	85	40	75	95	95	95	100
Surinam Grass	60	5	0	0	0	-	-	0	0	20	0	0	0	60
Velvetleaf	60	45	0	50	60	-	-	85	0	0	70	55	20	90
Wheat	-	-	-	-	-	30	40	-	-	-	40	-	-	10
Windgrass	-	-	-	-	-	50	55	-	-	-	40	-	-	55

Table C 125 g ai/ha Postemergence	65	76	78	79	83	88	94	117	129	133	135	136
Barley	50	–	30	35	–	–	–	–	45	–	–	55
Bermudagrass	70	75	60	–	55	70	80	90	–	85	75	85
Blackgrass	65	–	5	60	–	–	–	–	50	–	–	65
Bromegrass, Downy	55	–	15	35	–	–	–	–	0	–	–	55
Canarygrass	45	–	0	35	–	–	–	–	30	–	–	65
Chickweed	70	95	–	–	30	100	95	–	–	45	85	50
Cocklebur	100	100	100	–	100	90	100	90	–	95	100	100
Corn	90	70	40	–	60	–	60	–	–	80	35	75
Crabgrass	90	90	90	–	75	80	85	90	–	80	75	75
Cupgrass, Woolly	85	95	–	–	60	85	90	85	–	70	80	70
Foxtail, Giant	70	85	65	–	40	80	80	80	–	75	75	85
Foxtail, Green	70	–	70	60	–	–	–	–	60	–	–	70
Goosegrass	70	50	40	–	45	75	80	80	–	70	55	80
Johnsongrass	85	95	20	–	70	75	90	50	–	95	70	95
Kochia	90	100	95	–	90	95	100	90	–	85	95	90
Lambsquarters	95	100	95	–	100	95	100	95	–	100	95	95
Morningglory	95	100	100	–	90	85	100	50	–	100	95	100
Nutsedge, Yellow	50	60	0	–	75	55	75	60	–	80	40	75
Oat, Wild	40	–	60	45	–	–	–	–	40	–	–	60
Pigweed	100	100	95	–	100	100	100	95	–	100	100	100
Ragweed	95	100	95	–	95	100	100	100	–	95	95	95
Ryegrass, Italian	60	–	20	45	–	–	–	–	60	–	–	65
Soybean	100	100	100	–	100	100	100	100	–	100	100	100
Surinam Grass	80	–	55	–	65	80	100	80	–	70	60	70
Velvetleaf	90	95	95	–	100	95	95	95	–	95	95	95
Wheat	45	–	30	40	–	–	–	–	35	–	–	55
Windgrass	70	–	30	50	–	–	–	–	60	–	–	65

Table C 62 g ai/ha Postemergence	1	2	3	4	5	7	8	9	10	11	15	16	17	19
Barley	–	35	0	30	–	–	–	–	–	–	–	–	–	35
Bermudagrass	70	60	0	40	5	0	50	65	0	0	0	0	0	30
Blackgrass	–	65	0	65	–	–	–	–	–	–	–	–	–	65
Bromegrass, Downy	–	35	20	45	–	–	–	–	–	–	–	–	–	50
Canarygrass	–	40	10	35	–	–	–	–	–	–	–	–	–	60

Chickweed	80	65	0	30	0	0	20	85	0	0	20	0	0	5
Cocklebur	90	75	65	85	80	30	80	85	0	25	85	95	100	50
Corn	10	15	0	0	10	0	0	55	0	0	15	0	0	0
Crabgrass	30	55	0	70	40	0	60	70	0	0	15	15	0	70
Cupgrass, Woolly	65	60	0	60	5	0	30	60	0	0	0	0	0	65
Foxtail, Giant	40	35	0	60	20	0	40	65	0	0	45	20	0	40
Foxtail, Green	–	55	30	65	–	–	–	–	–	–	–	–	–	45
Goosegrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Johnsongrass	30	0	0	70	0	0	30	65	0	0	20	0	0	0
Kochia	100	95	65	100	100	40	95	100	80	75	95	100	100	90
Lambsquarters	100	100	90	100	95	50	75	95	60	70	100	100	100	90
Morningglory	100	75	60	15	95	–	95	95	70	0	90	95	95	80
Nutsedge, Yellow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oat, Wild	–	55	30	60	–	–	–	–	–	–	–	–	–	60
Pigweed	90	80	65	100	85	20	70	70	65	80	65	90	65	65
Ragweed	100	85	75	100	90	25	60	80	45	65	75	85	85	70
Ryegrass, Italian	–	45	35	45	–	–	–	–	–	–	–	–	–	65
Soybean	100	100	75	100	95	25	95	100	70	80	95	95	95	75
Surinam Grass	90	55	0	60	0	0	40	65	0	0	0	0	0	45
Velvetleaf	85	70	55	80	55	0	60	75	65	60	65	60	50	50
Wheat	–	60	0	50	–	–	–	–	–	–	–	–	–	40
Windgrass	–	65	30	60	–	–	–	–	–	–	–	–	–	60

Table C						Compounds								
62 g ai/ha	22	25	27	28	30	34	35	37	42	47	49	50	51	64
Postemergence														
Barley	–	–	–	–	–	20	20	–	–	–	0	–	–	20
Bermudagrass	50	0	0	0	0	–	–	0	0	0	0	50	0	60
Blackgrass	–	–	–	–	–	35	50	–	–	–	40	–	–	45
Bromegrass, Downy	–	–	–	–	–	0	30	–	–	–	0	–	–	15
Canarygrass	–	–	–	–	–	30	35	–	–	–	0	–	–	5
Chickweed	30	40	0	0	50	–	–	0	0	0	0	0	0	0
Cocklebur	90	90	20	85	95	–	–	0	0	60	75	40	65	90
Corn	30	0	0	0	0	–	–	0	0	0	0	0	0	50
Crabgrass	50	30	0	0	0	–	–	0	0	0	0	60	0	80
Cupgrass, Woolly	60	0	0	0	0	–	–	0	0	0	0	0	0	40
Foxtail, Giant	40	5	0	0	0	–	–	0	0	0	0	0	0	20
Foxtail, Green	–	–	–	–	–	40	40	–	–	–	0	–	–	30
Goosegrass	10	0	0	0	0	–	–	0	0	0	0	0	0	35

Johnsongrass	40	10	0	0	5	–	–	0	0	0	–	0	0	80
Kochia	95	85	0	75	90	–	–	0	30	20	20	20	15	85
Lambsquarters	90	85	20	60	60	–	–	0	20	70	70	70	60	90
Morningglory	90	90	20	80	90	–	–	0	50	40	50	65	80	90
Nutsedge, Yellow	0	0	0	0	0	–	–	0	0	0	0	0	0	50
Oat, Wild	–	–	–	–	–	40	30	–	–	–	30	–	–	5
Pigweed	85	80	5	30	70	–	–	0	10	45	65	75	65	95
Ragweed	80	65	5	65	80	–	–	0	10	40	45	20	65	80
Ryegrass, Italian	–	–	–	–	–	40	40	–	–	–	30	–	–	30
Soybean	95	90	30	75	90	–	–	20	30	65	95	95	75	90
Surinam Grass	55	0	0	0	0	–	–	0	0	0	0	0	0	60
Velvetleaf	55	45	0	45	10	–	–	0	0	0	45	50	0	85
Wheat	–	–	–	–	–	20	35	–	–	–	20	–	–	0
Windgrass	–	–	–	–	–	40	40	–	–	–	40	–	–	55

Table C						Compounds							
62 g ai/ha	65	76	78	79	83	88	94	95	117	129	133	135	136
Postemergence													
Barley	50	–	5	35	–	–	–	–	–	45	–	–	50
Bermudagrass	70	75	60	–	20	70	75	85	85	–	85	60	80
Blackgrass	65	–	5	60	–	–	–	–	–	50	–	–	65
Bromegrass, Downy	50	–	10	30	–	–	–	–	–	0	–	–	45
Canarygrass	35	–	0	25	–	–	–	–	–	30	–	–	55
Chickweed	60	70	0	–	10	100	50	95	40	–	20	25	50
Cocklebur	100	100	100	–	70	90	90	100	90	–	95	–	100
Corn	90	55	40	–	50	0	35	35	–	–	60	20	65
Crabgrass	90	85	90	–	65	80	85	80	90	–	75	75	75
Cupgrass, Woolly	85	80	55	–	45	75	90	80	80	–	60	60	70
Foxtail, Giant	70	55	30	–	20	75	80	80	70	–	70	65	75
Foxtail, Green	60	–	40	30	–	–	–	–	–	40	–	–	70
Goosegrass	70	45	0	–	30	75	80	80	75	–	65	45	75
Johnsongrass	85	–	10	–	55	45	75	90	50	–	90	65	85
Kochia	85	95	90	–	75	95	95	95	90	–	85	90	90
Lambsquarters	90	100	95	–	95	95	95	100	95	–	95	90	95
Morningglory	90	95	90	–	90	–	90	95	50	–	100	95	90
Nutsedge, Yellow	20	40	0	–	60	45	70	75	50	–	75	15	75
Oat, Wild	20	–	10	25	–	–	–	–	–	40	–	–	55
Pigweed	100	100	80	–	100	100	100	100	95	–	95	100	100
Ragweed	95	95	85	–	75	100	95	95	100	–	85	85	90

Ryegrass, Italian	55	–	10	40	–	–	–	–	–	55	–	–	60
Soybean	100	95	100	–	100	100	100	100	100	–	100	100	100
Surinam Grass	80	95	55	–	45	60	90	75	80	–	55	60	65
Velvetleaf	80	95	80	–	85	90	95	100	95	–	85	–	90
Wheat	45	–	20	30	–	–	–	–	–	35	–	–	45
Windgrass	70	–	30	45	–	–	–	–	–	60	–	–	65

Table C							Compounds							
31 g ai/ha	2	3	9	11	16	17	19	25	30	34	42	47	64	65
Postemergence														
Barley	0	0	–	–	–	–	25	–	–	20	–	–	20	40
Bermudagrass	15	0	60	0	0	0	5	0	0	–	0	0	20	60
Blackgrass	60	0	–	–	–	–	60	–	–	0	–	–	40	60
Bromegrass, Downy	20	20	–	–	–	–	0	–	–	0	–	–	10	50
Canarygrass	30	10	–	–	–	–	60	–	–	20	–	–	5	30
Chickweed	60	0	15	0	0	0	0	–	40	–	0	0	0	60
Cocklebur	65	60	40	0	75	95	25	85	90	–	0	45	90	100
Corn	15	0	45	0	0	0	0	0	0	–	0	0	20	90
Crabgrass	40	0	60	0	0	0	40	0	0	–	0	0	70	80
Cupgrass, Woolly	40	0	40	0	0	0	25	0	0	–	0	0	30	80
Foxtail, Giant	0	0	60	0	0	0	5	0	0	–	0	0	0	60
Foxtail, Green	55	20	–	–	–	–	35	–	–	40	–	–	0	55
Goosegrass	0	0	0	0	0	0	0	0	0	–	0	0	35	50
Johnsongrass	0	0	55	0	0	0	0	10	0	–	0	–	60	60
Kochia	85	20	95	65	95	100	90	80	55	–	5	0	80	85
Lambsquarters	100	75	90	60	95	95	90	60	50	–	10	45	80	90
Morningglory	70	45	90	0	85	95	55	90	90	–	0	35	90	90
Nutsedge, Yellow	0	0	0	0	0	0	0	0	0	–	0	0	40	0
Oat, Wild	20	30	–	–	–	–	40	–	–	20	–	–	5	15
Pigweed	65	60	55	70	85	45	50	50	60	–	10	15	85	90
Ragweed	65	55	70	45	60	65	40	50	60	–	0	0	75	90
Ryegrass, Italian	35	35	–	–	–	–	65	–	–	40	–	–	5	50
Soybean	100	60	95	60	85	85	55	90	80	–	10	40	90	100
Surinam Grass	0	0	45	0	0	0	25	0	0	–	0	0	20	80
Velvetleaf	65	25	0	50	55	25	40	20	10	–	0	0	80	80
Wheat	20	0	–	–	–	–	30	–	–	0	–	–	0	40
Windgrass	65	10	–	–	–	–	40	–	–	40	–	–	40	60

Table C	Compounds											
31 g ai/ha	76	78	79	83	88	94	95	117	129	133	135	136
Postemergence												
Barley	–	5	30	–	–	–	–	–	40	–	–	50
Bermudagrass	70	60	–	5	50	70	85	65	–	85	–	80
Blackgrass	–	0	40	–	–	–	–	–	45	–	–	55
Bromegrass, Downy	–	5	20	–	–	–	–	–	0	–	–	–
Canarygrass	–	0	20	–	–	–	–	–	30	–	–	45
Chickweed	45	0	–	0	80	45	–	–	–	10	15	50
Cocklebur	100	90	–	70	90	80	100	–	–	85	100	100
Corn	35	40	–	15	0	35	–	30	–	40	10	35
Crabgrass	75	55	–	45	75	80	80	90	–	75	75	75
Cupgrass, Woolly	60	50	–	15	70	80	75	80	–	50	60	65
Foxtail, Giant	25	0	–	0	55	65	75	55	–	60	60	75
Foxtail, Green	–	25	20	–	–	–	–	–	40	–	–	65
Goosegrass	45	0	–	10	50	60	75	40	–	55	35	65
Johnsongrass	65	10	–	55	30	60	75	50	–	85	35	85
Kochia	95	90	–	75	85	90	95	90	–	80	90	80
Lambsquarters	95	90	–	95	90	95	100	95	–	95	90	95
Morningglory	95	90	–	85	60	80	80	50	–	90	90	85
Nutsedge, Yellow	30	0	–	60	40	60	60	50	–	75	0	65
Oat, Wild	–	5	25	–	–	–	–	–	35	–	–	45
Pigweed	95	50	–	95	95	100	100	95	–	85	95	100
Ragweed	90	70	–	70	90	90	95	95	–	80	80	85
Ryegrass, Italian	–	0	35	–	–	–	–	–	55	–	–	50
Soybean	95	90	–	90	100	100	100	100	–	95	–	100
Surinam Grass	70	50	–	30	45	60	70	50	–	45	50	65
Velvetleaf	80	50	–	85	85	90	100	70	–	85	90	85
Wheat	–	20	20	–	–	–	–	–	35	–	–	40
Windgrass	–	5	40	–	–	–	–	–	45	–	–	60

Table C	Compounds													
16 g ai/ha	11	19	25	47	65	76	79	83	94	95	117	129	133	135
Postemergence														
Barley	–	25	–	–	40	–	0	–	–	–	–	35	–	–
Bermudagrass	0	0	0	0	60	15	–	0	60	70	60	–	50	40
Blackgrass	–	55	–	–	50	–	20	–	–	–	–	35	–	–
Bromegrass, Downy	–	0	–	–	40	–	0	–	–	–	–	0	–	–
Canarygrass	–	45	–	–	30	–	0	–	–	–	–	0	–	–

Chickweed	0	0	0	0	60	35	–	0	–	–	30	–	0	0
Cocklebur	0	25	70	35	90	100	–	60	75	100	90	–	75	90
Corn	0	0	0	0	5	10	–	5	10	20	30	–	35	5
Crabgrass	0	20	0	0	80	55	–	25	70	75	85	–	50	65
Cupgrass, Woolly	0	0	0	0	60	55	–	15	60	75	60	–	35	30
Foxtail, Giant	0	0	0	0	50	15	–	0	30	–	50	–	15	10
Foxtail, Green	–	30	–	–	50	–	20	–	–	–	–	40	–	–
Goosegrass	0	0	0	0	50	30	–	10	35	65	40	–	15	5
Johnsongrass	0	0	0	–	45	25	–	10	55	70	10	–	70	15
Kochia	40	80	10	0	85	90	–	65	75	95	90	–	75	75
Lambsquarters	50	70	30	0	85	90	–	90	95	100	95	–	95	60
Morningglory	0	–	90	20	90	95	–	70	60	–	20	–	80	80
Nutsedge, Yellow	0	0	0	0	0	10	–	60	55	60	5	–	60	0
Oat, Wild	–	40	–	–	5	–	0	–	–	–	–	30	–	–
Pigweed	60	50	50	0	90	85	–	95	95	95	90	–	85	85
Ragweed	15	35	40	0	80	80	–	65	90	95	95	–	80	75
Ryegrass, Italian	–	65	–	–	10	–	35	–	–	–	–	45	–	–
Soybean	45	45	40	20	100	95	–	85	100	100	100	–	95	100
Surinam Grass	0	0	0	0	60	60	–	20	50	65	45	–	35	45
Velvetleaf	20	30	5	0	65	45	–	70	75	95	60	–	80	55
Wheat	–	10	–	–	40	–	0	–	–	–	–	0	–	–
Windgrass	–	40	–	–	50	–	40	–	–	–	–	40	–	–

Table C	Compound
16 g ai/ha	136
Postemergence	
Barley	40
Bermudagrass	75
Blackgrass	40
Bromegrass, Downy	30
Canarygrass	40
Chickweed	45
Cocklebur	95
Corn	35
Crabgrass	60
Cupgrass, Woolly	55
Foxtail, Giant	65
Foxtail, Green	45
Goosegrass	50

Table C	Compound
8 g ai/ha	95
Postemergence	
Bermudagrass	70
Chickweed	95
Cocklebur	100
Corn	20
Crabgrass	75
Cupgrass, Woolly	75
Foxtail, Giant	70
Goosegrass	50
Johnsongrass	55
Kochia	90
Lambsquarters	75
Morningglory	60
Nutsedge, Yellow	55

Johnsongrass	60
Kochia	75
Lambsquarters	95
Morningglory	65
Nutsedge, Yellow	60
Oat, Wild	40
Pigweed	90
Ragweed	75
Ryegrass, Italian	45
Soybean	95
Surinam Grass	55
Velvetleaf	85
Wheat	20
Windgrass	45

Pigweed	90
Ragweed	90
Soybean	100
Surinam Grass	55
Velvetleaf	95

Table C	Compounds													
500 g ai/ha	1	4	5	8	10	15	22	26	27	28	33	40	49	50
Preemergence														
Bermudagrass	90	95	70	100	0	70	90	0	0	35	0	70	95	95
Cocklebur	100	100	100	100	100	100	100	95	95	100	95	100	100	95
Corn	70	90	50	75	0	60	65	20	25	0	40	40	65	45
Crabgrass	95	95	60	0	0	100	100	–	85	–	100	100	100	95
Cupgrass, Woolly	95	95	0	100	0	95	95	0	15	0	0	95	25	40
Foxtail, Giant	90	85	60	0	0	80	60	10	20	0	50	35	65	70
Goosegrass	70	65	40	45	0	0	100	0	20	20	0	40	15	0
Johnsongrass	90	95	70	20	0	95	100	100	65	–	40	95	85	85
Kochia	100	100	100	100	65	100	–	50	45	100	50	–	100	90
Lambsquarters	100	100	100	100	95	100	100	90	100	100	–	100	100	100
Morningglory	100	100	100	100	100	100	100	90	100	100	95	100	100	100
Nightshade	100	100	100	–	95	100	100	100	100	100	100	100	100	100
Nutsedge, Yellow	50	80	0	100	–	20	95	0	20	0	0	0	0	0
Pigweed	100	100	100	95	85	100	100	100	100	100	90	100	100	100
Ragweed	100	100	100	100	85	100	100	90	95	100	90	100	100	100
Soybean	100	100	100	100	–	100	100	20	75	90	90	95	90	90
Sunflower	100	100	100	100	0	100	100	90	95	100	90	95	100	100
Surinam Grass	90	100	0	100	0	95	100	10	30	0	10	90	65	85
Velvetleaf	100	100	90	100	60	100	100	90	70	100	85	100	100	100

Table C 250 g ai/ha Preemergence	Compounds 1	2	3	4	5	8	9	10	12	13	15	16	17	22
Bermudagrass	70	0	0	45	30	100	100	0	20	0	0	0	0	50
Cocklebur	100	100	70	100	100	100	100	0	90	95	100	100	100	100
Corn	50	0	0	75	20	10	75	0	–	30	45	75	75	65
Crabgrass	90	50	0	85	20	0	100	0	0	0	95	95	80	95
Cupgrass, Woolly	90	45	0	95	0	100	100	0	100	0	85	65	85	95
Foxtail, Giant	90	30	0	75	10	0	80	0	0	5	65	75	75	20
Goosegrass	10	60	0	55	0	35	50	0	0	0	0	0	0	80
Johnsongrass	80	40	0	90	60	0	90	0	5	45	75	80	75	100
Kochia	100	100	30	100	100	100	100	45	85	85	100	100	85	–
Lambsquarters	100	100	80	100	100	90	100	65	70	90	100	100	100	100
Morningglory	100	100	35	100	90	100	100	0	90	90	100	100	100	100
Nightshade	100	100	20	100	100	–	–	20	80	90	100	100	100	100
Nutsedge, Yellow	50	0	0	15	0	100	100	–	0	0	0	0	0	95
Pigweed	100	100	80	100	100	90	100	70	85	90	100	100	100	100
Ragweed	100	0	45	100	100	100	100	55	85	85	100	100	100	100
Soybean	100	100	20	100	98	100	100	–	70	90	95	100	100	100
Sunflower	100	100	0	100	100	100	100	0	85	90	100	100	100	100
Surinam Grass	90	0	0	85	0	100	100	0	0	10	75	80	0	100
Velvetleaf	95	90	35	95	90	100	100	0	70	90	100	100	100	100

Table C 250 g ai/ha Preemergence	Compounds 26	27	28	30	31	33	40	49	50	64
Bermudagrass	0	0	30	0	0	0	0	85	0	20
Cocklebur	90	70	95	90	85	90	90	95	95	30
Corn	0	15	0	0	0	30	20	15	20	30
Crabgrass	–	0	–	85	0	100	–	95	95	90
Cupgrass, Woolly	0	10	0	50	0	0	70	20	0	40
Foxtail, Giant	0	0	0	60	0	50	30	0	0	0
Goosegrass	0	0	0	50	20	0	5	0	0	75
Johnsongrass	0	45	0	5	5	10	80	80	65	60
Kochia	–	30	90	90	70	50	–	100	20	70
Lambsquarters	–	90	100	90	80	85	100	100	100	100
Morningglory	85	95	100	100	50	90	90	100	95	10
Nightshade	100	100	100	100	–	95	100	100	100	95
Nutsedge, Yellow	0	0	0	0	0	0	0	0	0	10

Pigweed	100	90	100	90	40	90	100	100	95	100
Ragweed	85	85	100	100	60	70	100	100	95	100
Soybean	10	20	65	70	80	80	90	90	75	85
Sunflower	70	90	100	90	70	80	90	100	95	85
Surinam Grass	10	20	0	20	0	0	10	40	65	90
Velvetleaf	90	50	95	50	60	60	90	90	85	0

Table C	Compounds													
125 g ai/ha	1	2	3	4	5	8	9	10	11	12	13	15	16	17
Preemergence														
Bermudagrass	50	0	0	20	0	100	100	0	0	0	0	0	0	0
Cocklebur	100	80	55	95	90	85	100	0	0	85	90	90	95	95
Corn	0	–	0	0	5	0	60	0	0	60	10	15	20	35
Crabgrass	60	0	0	65	0	0	95	0	60	0	0	95	65	20
Cupgrass, Woolly	60	0	0	80	0	65	95	0	0	10	0	20	15	20
Foxtail, Giant	30	0	0	40	0	0	75	0	20	0	0	0	0	20
Goosegrass	0	0	0	25	0	0	20	0	0	0	0	0	0	0
Johnsongrass	30	0	0	70	20	0	65	0	75	5	5	65	65	55
Kochia	100	95	20	100	95	85	100	0	60	50	80	100	100	25
Lambsquarters	100	100	0	100	95	20	100	50	85	40	90	100	100	100
Morningglory	100	100	20	100	80	100	100	0	0	60	85	100	100	100
Nightshade	100	100	0	100	100	–	–	–	–	60	90	100	95	95
Nutsedge, Yellow	0	0	0	0	0	0	100	0	–	0	0	0	0	0
Pigweed	100	95	65	100	90	85	100	55	90	50	85	100	100	100
Ragweed	100	0	0	100	90	100	100	0	45	20	70	95	95	95
Soybean	100	90	15	100	90	100	100	–	55	–	90	90	100	95
Sunflower	100	100	0	100	90	40	100	0	0	0	60	100	100	100
Surinam Grass	35	0	0	65	0	100	100	0	100	0	0	65	15	0
Velvetleaf	90	75	20	95	85	75	100	0	0	50	80	95	95	100

Table C	Compounds													
125 g ai/ha	19	22	25	26	27	28	30	31	33	40	47	49	50	64
Preemergence														
Bermudagrass	0	50	10	0	0	20	0	0	0	0	95	0	0	20
Cocklebur	80	95	85	70	50	95	85	75	0	70	75	95	85	5
Corn	0	50	0	0	10	0	0	0	0	20	0	15	10	20
Crabgrass	0	95	0	–	0	–	70	0	20	–	100	95	90	70
Cupgrass, Woolly	0	95	50	0	0	0	45	0	0	5	0	0	0	0
Foxtail, Giant	0	15	0	0	0	0	20	0	10	0	20	0	0	0

Goosegrass	0	0	0	0	0	0	35	0	0	0	90	0	0	0
Johnsongrass	55	100	0	–	20	–	5	0	5	80	0	65	55	50
Kochia	90	–	70	–	0	80	70	50	–	–	100	100	0	25
Lambsquarters	100	100	50	–	40	100	85	40	–	100	95	100	100	95
Morningglory	90	100	90	5	70	100	90	10	85	90	100	95	95	0
Nightshade	100	100	75	100	70	100	100	0	50	100	100	100	100	85
Nutsedge, Yellow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pigweed	95	100	85	100	80	95	80	35	90	100	85	90	90	100
Ragweed	80	100	85	10	65	95	90	60	20	90	65	100	85	95
Soybean	90	95	65	10	0	45	5	15	30	40	0	70	60	85
Sunflower	90	95	90	20	20	50	90	5	70	90	100	75	55	30
Surinam Grass	10	90	40	0	0	0	0	0	0	0	0	15	15	50
Velvetleaf	65	95	40	10	0	55	15	0	20	70	50	70	75	0

Table C	Compounds						
125 g ai/ha	65	75	76	77	78	117	135
Preemergence							
Bermudagrass	80	20	0	0	20	65	0
Cocklebur	90	100	90	95	90	90	100
Corn	30	65	45	35	40	25	70
Crabgrass	80	60	60	0	45	60	5
Cupgrass, Woolly	70	60	50	0	10	50	0
Foxtail, Giant	60	10	10	0	0	50	0
Goosegrass	50	30	0	0	0	30	40
Johnsongrass	70	55	50	0	50	70	40
Kochia	70	100	100	80	100	60	100
Lambsquarters	100	100	80	40	80	100	90
Morningglory	100	100	100	75	100	50	100
Nightshade	80	100	100	0	70	45	50
Nutsedge, Yellow	70	0	0	0	–	50	0
Pigweed	100	90	90	65	95	100	100
Ragweed	100	90	100	55	80	98	70
Soybean	100	100	95	100	95	100	100
Sunflower	100	100	100	100	100	100	90
Surinam Grass	80	55	45	0	75	95	0
Velvetleaf	100	100	90	90	80	90	100

Table C	Compounds													
62 g ai/ha	1	2	3	4	5	8	9	10	11	12	13	15	16	17
Preemergence														
Bermudagrass	0	0	0	0	0	100	100	0	0	0	0	0	0	0
Cocklebur	90	–	30	80	10	–	80	–	0	50	60	65	95	90
Corn	0	0	0	–	5	0	5	0	0	30	5	0	15	20
Crabgrass	10	0	0	40	0	0	95	0	0	0	0	0	0	0
Cupgrass, Woolly	0	0	0	0	0	0	90	0	0	0	0	0	0	0
Foxtail, Giant	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goosegrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Johnsongrass	0	0	0	50	5	0	45	0	0	0	0	20	40	0
Kochia	95	90	0	95	80	50	95	0	0	50	60	95	95	0
Lambsquarters	95	100	0	95	95	0	100	0	40	10	85	95	95	95
Morningglory	90	100	0	100	50	20	100	0	0	60	65	95	95	95
Nightshade	100	20	0	100	100	–	–	–	–	50	0	95	90	80
Nutsedge, Yellow	0	0	0	0	0	0	100	0	0	0	0	0	0	0
Pigweed	90	95	50	95	60	65	95	20	65	50	60	90	95	100
Ragweed	95	0	0	100	85	100	100	0	20	10	60	90	90	80
Soybean	85	75	0	95	85	100	100	0	–	50	60	75	85	90
Sunflower	80	100	0	100	60	20	100	0	0	0	50	65	85	95
Surinam Grass	0	0	0	0	0	0	100	–	100	–	0	15	0	0
Velvetleaf	80	50	0	75	85	65	95	0	0	5	60	80	90	80

Table C	Compounds													
62 g ai/ha	19	22	25	26	27	28	30	31	33	40	47	49	50	64
Preemergence														
Bermudagrass	0	0	0	0	0	0	0	0	0	0	0	0	–	0
Cocklebur	65	90	60	70	0	90	60	60	0	5	70	20	70	0
Corn	0	40	0	0	0	0	0	0	0	0	0	–	10	0
Crabgrass	0	90	0	–	0	–	0	0	0	5	100	95	90	0
Cupgrass, Woolly	0	40	0	0	0	0	5	0	0	5	0	0	0	0
Foxtail, Giant	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Goosegrass	0	0	0	0	0	0	30	0	0	0	85	0	0	0
Johnsongrass	35	80	0	0	0	–	0	0	0	0	0	45	0	5
Kochia	85	–	5	0	0	0	70	0	–	–	0	100	–	20
Lambsquarters	100	100	30	10	–	95	80	40	–	100	85	100	95	95
Morningglory	90	100	50	0	0	100	85	0	0	–	70	90	80	0
Nightshade	100	100	30	10	0	100	80	0	0	100	95	95	95	85
Nutsedge, Yellow	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pigweed	70	90	35	30	20	80	30	30	85	20	85	85	75	30
Ragweed	70	90	70	0	20	65	85	10	0	90	45	70	70	85
Soybean	85	95	60	0	0	0	5	5	0	10	0	0	0	85
Sunflower	70	90	75	0	0	45	80	0	0	5	20	15	15	0
Surinam Grass	0	–	0	0	0	0	0	0	0	–	0	0	0	0
Velvetleaf	40	90	0	0	0	50	10	0	0	0	20	15	65	0

Table C	Compounds							
62 g ai/ha	65	75	76	77	78	95	117	135
Preemergence								
Bermudagrass	70	0	0	0	0	55	30	0
Cocklebur	50	95	90	80	90	60	5	95
Corn	0	30	35	0	20	5	20	30
Crabgrass	70	20	5	0	40	35	0	0
Cupgrass, Woolly	5	60	20	0	0	5	15	0
Foxtail, Giant	50	0	0	0	0	35	5	0
Goosegrass	0	0	0	0	0	40	0	0
Johnsongrass	60	50	20	0	20	80	60	5
Kochia	50	100	95	50	100	45	20	75
Lambsquarters	80	80	80	–	80	100	100	70
Morningglory	20	95	100	50	85	60	5	90
Nightshade	–	70	60	0	60	75	40	35
Nutsedge, Yellow	30	0	0	0	0	60	50	0
Pigweed	80	80	80	65	70	100	90	80
Ragweed	90	80	80	50	80	100	90	35
Soybean	95	100	95	100	80	100	100	95
Sunflower	95	100	100	100	100	100	90	90
Surinam Grass	80	55	0	0	0	10	50	0
Velvetleaf	80	85	70	85	70	90	65	90

Table C	Compounds													
31 g ai/ha	2	3	9	11	12	13	16	17	19	25	30	31	47	64
Preemergence														
Bermudagrass	0	0	100	0	0	0	0	0	0	0	0	0	0	0
Cocklebur	60	0	75	0	50	40	45	75	30	20	0	0	0	0
Corn	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crabgrass	0	0	20	0	0	0	0	0	0	0	0	0	100	0
Cupgrass, Woolly	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Foxtail, Giant	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Goosegrass	0	0	0	0	0	0	0	0	0	0	0	0	45	0
Johnsongrass	0	0	15	0	0	0	0	0	0	0	0	0	0	5
Kochia	75	0	95	0	0	45	90	0	–	0	50	0	–	20
Lambsquarters	90	0	95	0	0	50	95	95	100	0	0	0	–	70
Morningglory	100	0	100	0	30	60	65	70	10	0	0	0	0	0
Nightshade	0	0	–	–	–	0	55	–	40	0	50	0	85	5
Nutsedge, Yellow	0	0	20	0	0	0	0	0	0	0	0	0	0	0
Pigweed	90	20	95	0	10	50	85	95	45	30	0	10	80	10
Ragweed	0	0	100	0	–	45	45	70	55	70	30	5	–	85
Soybean	15	0	100	–	–	0	75	70	25	–	0	0	0	0
Sunflower	20	0	100	0	0	5	20	60	25	60	20	0	0	0
Surinam Grass	0	0	95	0	0	0	0	0	–	0	0	0	0	–
Velvetleaf	20	0	70	0	0	60	25	20	35	0	0	0	20	0

Table C	Compounds							
31 g ai/ha	65	75	76	77	78	95	117	135
Preemergence								
Bermudagrass	50	0	0	0	0	0	0	0
Cocklebur	30	90	90	70	70	0	0	95
Corn	0	0	0	0	0	0	5	30
Crabgrass	20	10	0	0	5	30	0	0
Cupgrass, Woolly	0	0	0	0	0	0	0	0
Foxtail, Giant	10	0	0	0	0	30	0	0
Goosegrass	0	0	0	0	0	10	0	0
Johnsongrass	50	0	0	0	10	60	35	0
Kochia	0	80	90	–	80	40	5	75
Lambsquarters	50	75	70	0	70	100	100	70
Morningglory	0	90	60	50	70	10	0	90
Nightshade	0	50	40	0	30	60	5	30
Nutsedge, Yellow	0	0	0	0	0	60	0	0
Pigweed	80	75	80	60	60	100	80	70
Ragweed	85	70	60	0	65	100	60	–
Soybean	95	60	70	100	70	100	100	95
Sunflower	70	70	85	50	70	95	50	70
Surinam Grass	40	0	0	0	0	5	40	0
Velvetleaf	40	60	40	30	55	60	50	85

Table C	Compounds											
16 g ai/ha	11	19	25	47	65	75	76	77	78	95	117	135
Preemergence												
Bermudagrass	0	0	0	0	0	0	0	0	0	0	0	0
Cocklebur	0	15	0	0	0	55	65	55	55	0	0	85
Corn	0	0	0	0	0	–	0	0	0	0	0	5
Crabgrass	0	0	0	20	0	0	0	0	0	0	0	0
Cupgrass, Woolly	0	0	0	0	0	0	0	0	0	0	0	0
Foxtail, Giant	0	0	0	0	0	0	0	0	0	0	0	0
Goosegrass	0	0	0	0	0	0	0	0	0	0	0	0
Johnsongrass	0	0	0	0	0	0	0	0	0	50	0	0
Kochia	0	35	0	0	0	70	70	20	70	0	0	60
Lambsquarters	0	75	0	0	0	70	70	0	0	100	20	0
Morningglory	0	10	0	0	0	50	40	5	0	0	0	85
Nightshade	–	0	0	80	0	0	30	0	0	0	0	0
Nutsedge, Yellow	0	0	0	0	0	0	0	0	0	40	0	0
Pigweed	0	35	0	0	40	70	60	60	55	90	50	70
Ragweed	0	55	0	0	85	20	50	0	10	90	60	5
Soybean	–	0	30	0	85	55	50	40	30	90	85	85
Sunflower	0	10	5	0	40	50	50	20	50	40	0	65
Surinam Grass	0	0	0	0	0	0	0	0	0	0	40	0
Velvetleaf	0	25	0	0	0	5	30	10	10	0	0	60

Table C	Compound
8 g ai/ha	95
Preemergence	
Bermudagrass	0
Cocklebur	0
Corn	0
Crabgrass	0
Cupgrass, Woolly	0
Foxtail, Giant	0
Goosegrass	0
Johnsongrass	0
Kochia	0
Lambsquarters	0
Morningglory	0
Nightshade	0
Nutsedge, Yellow	0
Pigweed	50
Ragweed	65
Soybean	90
Sunflower	5
Surinam Grass	0
Velvetleaf	0

TEST D

Seeds of plant species selected from catchweed bedstraw (galium; *Galium aparine*), common chickweed (*Stellaria media*), kochia (*Kochia scoparia*), lambsquarters (*Chenopodium album*), pigweed (*Amaranthus retroflexus*), Russian thistle (*Salsola kali*), wild buckwheat (*Polygonum convolvulus*), wild mustard (*Sinapis arvensis*), winter barley

(*Hordeum vulgare*), and wheat (*Triticum aestivum*) were planted and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant.

At the same time, plants selected from these crop and weed species were treated with postemergence applications of some of the test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage) for postemergence treatments. Treated plants and controls were maintained in a controlled growth environment for 15 to 25 days after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table D, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

Table D	Compound
500 g ai/ha	58
Postemergence	
Buckwheat, Wild	100
Galium	100
Kochia	100
Lambsquarters	100
Mustard, Wild	100
Pigweed	100
Russian Thistle	80
Wheat	85

Table D	Compounds					
250 g ai/ha	26	28	33	35	47	58
Postemergence						
Barley	50	40	45	70	–	–
Buckwheat, Wild	55	60	55	80	70	100
Chickweed	55	65	60	85	70	–
Galium	85	100	65	100	98	100
Kochia	55	75	50	85	75	100
Lambsquarters	50	75	45	100	45	100
Mustard, Wild	75	60	50	75	70	100
Pigweed	70	70	55	100	65	100
Russian Thistle	40	70	40	100	70	70
Wheat	20	35	45	70	45	70

Table D	Compounds									
125 g ai/ha	1	2	4	9	26	28	33	35	47	58
Postemergence										
Barley	–	–	–	–	45	40	45	65	–	–
Buckwheat, Wild	80	95	100	100	35	55	50	70	65	90
Chickweed	85	85	100	100	45	65	50	80	65	–
Galium	100	100	100	100	70	–	60	100	80	100
Kochia	100	100	100	100	35	75	50	85	65	100
Lambsquarters	100	100	100	100	40	70	30	100	40	85
Mustard, Wild	75	80	90	95	60	60	50	75	65	100
Pigweed	100	100	100	100	60	60	55	100	55	100
Russian Thistle	100	100	100	100	40	70	40	100	65	70
Wheat	100	100	100	100	45	35	40	65	35	60

Table D	Compounds								
62 g ai/ha	1	2	4	9	28	33	35	47	58
Postemergence									
Barley	-	-	-	-	20	45	65	-	-
Buckwheat, Wild	80	90	100	100	35	40	60	65	65
Chickweed	65	85	100	100	65	40	80	60	-
Galium	100	100	100	100	100	55	100	75	100
Kochia	100	100	100	100	70	50	80	50	70
Lambsquarters	100	100	100	100	65	30	100	35	80
Mustard, Wild	70	70	75	80	45	50	75	60	100
Pigweed	100	100	100	100	60	45	100	50	80
Russian Thistle	85	95	100	100	65	30	100	55	70
Wheat	90	100	100	90	20	35	0	35	55

Table D	Compounds				
31 g ai/ha	1	2	4	9	47
Postemergence					
Buckwheat, Wild	80	65	85	80	60
Chickweed	65	60	100	100	35
Galium	100	100	100	100	65
Kochia	100	100	100	100	45
Lambsquarters	95	100	100	100	35
Mustard, Wild	70	65	65	80	55
Pigweed	100	85	100	100	35
Russian Thistle	65	85	90	90	45
Wheat	80	70	85	80	30

Table D	Compounds			
16 g ai/ha	1	2	4	9
Postemergence				
Buckwheat, Wild	50	45	80	65
Chickweed	65	60	65	60
Galium	95	75	100	100
Kochia	85	75	85	85
Lambsquarters	95	60	95	95
Mustard, Wild	60	65	65	65
Pigweed	60	65	85	65
Russian Thistle	45	65	80	65
Wheat	40	70	80	50

Table D	Compound
500 g ai/ha	58
Preemergence	
Buckwheat, Wild	100
Chickweed	100
Galium	100
Kochia	100
Lambsquarters	100
Mustard, Wild	100
Pigweed	100
Russian Thistle	85
Wheat	70

Table D	Compounds				
250 g ai/ha	26	28	33	35	58
Preemergence					
Barley	35	45	45	45	-
Buckwheat, Wild	95	60	65	65	100
Chickweed	65	60	65	100	75
Galium	100	100	100	100	100
Kochia	75	100	65	100	100
Lambsquarters	65	60	65	80	100
Mustard, Wild	65	60	65	75	100
Pigweed	100	80	90	85	100
Russian Thistle	100	100	85	100	70
Wheat	35	35	55	50	60

Table D	Compounds								
125 g ai/ha	1	2	4	9	26	28	33	35	58
Preemergence									
Barley	-	-	-	-	25	25	35	45	-
Buckwheat, Wild	75	85	100	100	65	45	65	60	80
Chickweed	75	90	100	100	60	60	-	100	-
Galium	100	100	100	100	85	100	80	100	100
Kochia	100	100	100	100	55	80	65	100	95
Lambsquarters	100	100	100	100	60	60	65	75	100
Mustard, Wild	90	85	85	85	65	60	65	70	100
Pigweed	100	100	100	100	65	-	70	80	100
Russian Thistle	100	100	100	100	-	80	60	100	65
Wheat	70	70	80	-	25	35	35	40	50

Table D	Compounds							
62 g ai/ha	1	2	4	9	28	33	35	58
Preemergence								
Barley	-	-	-	-	10	10	40	-
Buckwheat, Wild	70	80	100	100	45	55	55	40
Chickweed	70	75	85	100	60	-	60	60
Galium	100	98	100	100	100	70	85	100
Kochia	100	100	100	100	45	60	75	35
Lambsquarters	85	95	100	100	60	60	65	60
Mustard, Wild	70	70	85	85	60	65	65	65
Pigweed	95	85	100	100	45	60	65	70

Russian Thistle	100	100	100	100	45	55	85	40
Wheat	70	70	80	75	20	15	35	25

Table D	Compounds			
31 g ai/ha	1	2	4	9
Preemergence				
Buckwheat, Wild	60	65	80	85
Chickweed	65	60	70	95
Galium	80	90	100	100
Kochia	75	70	100	98
Lambsquarters	75	85	80	100
Mustard, Wild	65	70	85	70
Pigweed	70	70	90	80
Russian Thistle	100	100	100	100
Wheat	70	60	70	75

Table D	Compounds			
16 g ai/ha	1	2	4	9
Preemergence				
Buckwheat, Wild	45	45	60	60
Chickweed	60	60	65	65
Galium	80	80	90	85
Kochia	65	55	85	70
Lambsquarters	65	–	70	65
Mustard, Wild	50	50	65	60
Pigweed	60	65	70	65
Russian Thistle	100	85	90	100
Wheat	35	45	–	60

TEST E

Three plastic pots (ca. 16-cm diameter) per rate were partially filled with sterilized Tama silt loam soil comprising a 35:50:15 ratio of sand, silt and clay and 2.6% organic matter. Separate plantings for each of the three pots were as follows. Seeds from the U.S. of ducksalad (*Heteranthera limosa*), smallflower umbrella sedge (*Cyperus difformis*) and purple redstem (*Ammannia coccinea*), were planted into one 16-cm pot for each rate. Seeds from the U.S. of rice flatsedge (*Cyperus iria*), bearded (brdd.) sprangletop (*Leptochloa fusca* ssp. *fascicularis*), one stand of 9 or 10 water seeded rice seedlings (*Oryza sativa* cv. 'Japonica – M202'), and one stand of 6 transplanted rice seedlings (*Oryza sativa* cv. 'Japonica – M202') were planted into one 16-cm pot for each rate. Seeds from the U.S. of barnyardgrass (*Echinochloa crus-galli*), late watergrass (*Echinochloa oryzicola*), early watergrass (*Echinochloa oryzoides*) and junglerice (*Echinochloa colona*) were planted into one 16-cm pot for each rate. Plantings were sequential so that crop and weed species were at the 2.0 to 2.5-leaf stage at time of treatment.

Potted plants were grown in a greenhouse with day/night temperature settings of 29.5/26.7 °C, and supplemental balanced lighting was provided to maintain a 16-hour photoperiod. Test pots were maintained in the greenhouse until test completion.

At time of treatment, test pots were flooded to 3 cm above the soil surface, treated by application of test compounds directly to the paddy water, and then maintained at that water depth for the duration of the test. Effects of treatments on rice and weeds were visually evaluated by comparison to untreated controls after 21 days. Plant response ratings, summarized in Table E, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

Table E	Compounds		
500 g ai/ha	44	61	62
Flood			
Barnyardgrass	10	65	100
Ducksalad	100	100	100
Flatsedge, Rice	-	95	100
Junglerice	20	25	65
Redstem	75	100	100
Rice, Transplanted	0	25	30
Rice, Water Seeded	20	35	60
Sedge, Umbrella	100	100	100
Sprangletop, Brdd.	95	65	75
Watergrass, Early	0	25	0
Watergrass, Late	20	25	20

Table E	Compounds													
250 g ai/ha	37	44	58	61	62	63	64	65	66	67	69	70	71	72
Flood														
Barnyardgrass	0	0	-	0	50	-	-	-	35	40	-	0	60	0
Ducksalad	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Flatsedge, Rice	90	-	100	40	65	85	100	100	0	60	100	65	0	100
Junglerice	0	20	0	25	50	30	0	40	0	65	0	0	45	0
Redstem	80	50	95	100	95	75	80	60	100	85	30	0	30	100
Rice, Transplanted	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Rice, Water Seeded	0	0	20	10	10	30	0	10	0	0	0	0	0	0
Sedge, Umbrella	95	100	100	95	100	80	100	100	0	70	100	60	70	100
Sprangletop, Brdd.	0	50	60	65	45	65	0	40	0	30	0	0	60	0
Watergrass, Early	-	0	-	20	0	0	0	10	0	0	0	0	0	0
Watergrass, Late	0	0	0	20	20	0	20	25	0	0	0	0	0	0

Table E	Compounds													
250 g ai/ha	73	74	84	88	91	94	95	96	98	99	111	117	118	128
Flood														
Barnyardgrass	100	0	85	0	10	0	0	0	0	0	0	0	0	0
Ducksalad	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Flatsedge, Rice	45	95	80	100	-	100	0	100	100	100	0	100	100	80
Junglerice	0	65	50	90	70	0	0	0	0	0	0	0	65	10
Redstem	100	25	100	65	50	100	80	100	40	45	75	30	85	90
Rice, Transplanted	0	0	20	0	10	20	15	20	0	20	0	20	0	0
Rice, Water Seeded	0	0	30	0	20	10	15	10	0	20	0	0	0	0
Sedge, Umbrella	85	100	100	95	100	100	95	100	60	-	75	100	100	100
Sprangletop, Brdd.	70	0	40	95	30	40	0	0	0	0	0	0	85	80
Watergrass, Early	0	0	30	50	0	0	0	0	0	0	0	0	0	0

Watergrass, Late	20	0	20	0	0	0	0	0	0	0	0	0	0	0

Table E	Compounds	
250 g ai/ha	129	133
Flood		
Barnyardgrass	0	0
Ducksalad	100	100
Flatsedge, Rice	100	100
Junglerice	0	0
Redstem	95	85
Rice, Transplanted	0	0

Table E	Compounds	
250 g ai/ha	129	133
Flood		
Rice, Water Seeded	0	35
Sedge, Umbrella	100	100
Sprangletop, Brdd.	70	0
Watergrass, Early	0	0
Watergrass, Late	0	0

Table E	Compounds													
125 g ai/ha	37	44	58	61	62	63	64	65	66	67	69	70	71	72
Flood														
Barnyardgrass	0	0	–	0	0	–	–	–	0	40	0	0	0	0
Ducksalad	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Flatsedge, Rice	75	–	100	40	45	85	100	100	0	60	100	30	0	100
Junglerice	0	0	0	20	40	0	0	40	0	30	0	0	0	0
Redstem	40	20	95	80	85	75	60	50	40	0	0	0	0	35
Rice, Transplanted	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Rice, Water Seeded	0	0	0	0	0	20	0	0	0	0	0	0	0	0
Sedge, Umbrella	65	90	95	85	95	75	100	100	0	40	90	0	30	90
Sprangletop, Brdd.	0	30	60	60	30	40	0	40	0	30	0	0	0	0
Watergrass, Early	–	0	–	0	0	0	0	0	0	0	0	0	0	0
Watergrass, Late	0	0	0	20	20	0	20	0	0	0	0	0	0	0

Table E	Compounds													
125 g ai/ha	73	74	84	88	91	94	95	96	98	99	111	117	118	128
Flood														
Barnyardgrass	90	–	20	0	10	0	0	0	0	0	0	0	0	0
Ducksalad	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Flatsedge, Rice	–	90	60	100	–	100	0	100	100	100	0	100	95	60
Junglerice	0	0	50	0	0	0	0	0	0	0	0	0	65	0
Redstem	100	20	70	0	30	100	70	100	40	0	30	0	50	90
Rice, Transplanted	0	0	0	0	0	10	0	10	0	0	0	0	0	0
Rice, Water Seeded	0	0	0	0	10	10	0	10	0	20	0	0	0	0
Sedge, Umbrella	35	95	90	85	100	100	95	100	60	–	0	100	100	100
Sprangletop, Brdd.	50	0	0	85	30	20	0	0	0	0	0	0	70	0
Watergrass, Early	0	0	20	0	0	0	0	0	0	0	0	0	0	0

Watergrass, Late	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table E	Compounds	
125 g ai/ha	129	133
Flood		
Barnyardgrass	0	0
Ducksalad	100	100
Flatsedge, Rice	100	95
Junglerice	0	0
Redstem	80	75
Rice, Transplanted	0	0
Rice, Water Seeded	0	0
Sedge, Umbrella	100	100
Sprangletop, Brdd.	0	0
Watergrass, Early	0	0
Watergrass, Late	0	0

Table E	Compounds													
64 g ai/ha	37	44	58	61	62	63	64	65	66	67	69	70	71	72
Flood														
Barnyardgrass	0	0	–	0	0	–	–	–	–	0	0	0	0	–
Ducksalad	100	100	100	100	100	65	100	100	100	100	100	100	100	100
Flatsedge, Rice	0	–	100	0	0	75	90	100	0	30	100	0	0	100
Junglerice	0	0	0	20	30	0	0	0	0	0	0	0	0	0
Redstem	30	10	85	80	85	65	60	30	0	0	0	0	0	25
Rice, Transplanted	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice, Water Seeded	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	50	90	95	75	80	75	85	85	0	0	30	0	0	75
Sprangletop, Brdd.	0	30	60	35	0	40	0	0	0	0	0	0	–	0
Watergrass, Early	–	0	–	0	0	0	0	0	0	0	0	0	0	0
Watergrass, Late	0	0	0	20	20	0	0	0	0	0	0	0	0	0

Table E	Compounds													
64 g ai/ha	73	74	84	88	91	94	95	96	98	99	111	117	118	128
Flood														
Barnyardgrass	0	0	0	0	10	0	0	0	0	0	0	0	0	0
Ducksalad	100	100	100	100	100	100	100	100	100	100	85	100	100	100
Flatsedge, Rice	0	0	60	100	–	100	0	100	100	100	0	100	95	0
Junglerice	0	0	0	0	0	0	0	0	0	0	0	0	45	0
Redstem	90	0	20	0	0	75	30	90	0	–	30	0	30	80
Rice, Transplanted	0	0	0	0	0	10	0	0	0	0	0	0	0	0
Rice, Water Seeded	0	0	0	0	10	–	0	0	0	0	0	0	0	0
Sedge, Umbrella	0	80	80	–	30	100	95	100	60	–	0	100	100	70
Sprangletop, Brdd.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Watergrass, Early	0	0	10	0	0	0	0	0	0	0	0	0	0	0

Watergrass, Late	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table E	Compounds	
64 g ai/ha	129	133
Flood		
Barnyardgrass	0	0
Ducksalad	100	100
Flatsedge, Rice	100	95
Junglerice	0	0
Redstem	75	65
Rice, Transplanted	0	0
Rice, Water Seeded	0	0
Sedge, Umbrella	80	95
Sprangletop, Brdd.	0	0
Watergrass, Early	0	0
Watergrass, Late	0	0

Table E	Compounds													
32 g ai/ha	37	44	58	61	62	63	64	65	66	67	69	70	71	72
Flood														
Barnyardgrass	0	0	–	0	0	–	–	–	0	0	0	0	0	0
Ducksalad	100	100	100	100	100	30	100	100	100	100	100	40	100	80
Flatsedge, Rice	0	–	100	0	0	75	85	80	0	0	70	0	0	100
Junglerice	0	0	0	0	20	0	0	0	0	0	0	0	0	0
Redstem	0	0	80	65	75	65	60	30	0	0	0	0	0	25
Rice, Transplanted	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice, Water Seeded	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	50	20	95	20	70	75	80	80	0	0	0	0	0	30
Sprangletop, Brdd.	0	20	40	35	0	0	0	0	0	0	0	0	0	0
Watergrass, Early	–	0	–	0	0	0	0	0	0	0	0	0	0	0
Watergrass, Late	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table E	Compounds													
32 g ai/ha	73	74	84	88	91	94	95	96	98	99	111	117	118	128
Flood														
Barnyardgrass	–	0	0	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	100	100	100	100	100	100	100	100	100	100	0	100	100	100
Flatsedge, Rice	0	0	35	85	–	100	0	100	80	–	0	100	95	0
Junglerice	0	0	0	0	0	0	0	0	0	0	0	0	40	0
Redstem	0	0	20	0	0	65	–	85	0	0	20	0	20	75
Rice, Transplanted	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice, Water Seeded	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	0	0	80	40	0	100	95	100	60	–	0	85	95	60
Sprangletop, Brdd.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Watergrass, Early	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Watergrass, Late	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table E	Compounds	
32 g ai/ha	129	133
Flood		
Barnyardgrass	0	0
Ducksalad	100	100
Flatsedge, Rice	100	65
Junglerice	0	0
Redstem	60	20
Rice, Transplanted	0	0
Rice, Water Seeded	0	0
Sedge, Umbrella	60	0
Sprangletop, Brdd.	0	0
Watergrass, Early	0	0
Watergrass, Late	0	0

Table E	Compounds													
16 g ai/ha	37	58	63	64	65	66	67	69	70	71	72	73	74	84
Flood														
Barnyardgrass	0	–	–	–	–	0	0	0	0	0	–	0	0	0
Ducksalad	80	100	30	100	100	95	85	95	0	100	80	75	100	100
Flatsedge, Rice	0	40	60	75	0	0	0	65	0	0	90	0	0	25
Junglerice	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Redstem	0	60	65	20	0	0	0	0	0	0	0	0	0	0
Rice, Transplanted	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice, Water Seeded	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	30	65	70	65	20	0	0	0	0	0	0	0	0	70
Sprangletop, Brdd.	0	20	0	0	0	0	0	0	0	–	0	0	0	0
Watergrass, Early	–	–	0	0	0	0	0	0	0	0	0	0	0	0
Watergrass, Late	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table E	Compounds												
16 g ai/ha	88	91	94	95	96	98	99	111	117	118	128	129	133
Flood													
Barnyardgrass	0	0	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	95	100	100	100	100	0	95	0	100	100	95	100	100
Flatsedge, Rice	50	–	100	0	100	80	100	0	100	85	0	100	30
Junglerice	0	0	0	0	0	0	0	0	0	0	0	0	0
Redstem	0	0	0	30	0	0	0	0	0	0	0	30	0
Rice, Transplanted	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice, Water Seeded	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	40	0	100	0	100	60	–	0	60	85	0	0	0
Sprangletop, Brdd.	0	–	0	0	0	0	0	0	0	0	0	0	0
Watergrass, Early	0	0	0	0	0	0	0	0	0	0	0	0	0

Watergrass, Late	0	0	0	0	0	0	0	0	0	0	0	0	0

TEST F

Seeds or nutlets of plant species selected from (turf) bermudagrass (*Cynodon dactylon*), Kentucky bluegrass (*Poa pratensis*), bentgrass (*Agrostis palustris*), hard fescue (*Festuca ovina*), large crabgrass (*Digitaria sanguinalis*), goosegrass (*Eleusine indica*), dallisgrass (*Paspalum dilatatum*), annual bluegrass (*Poa annua*), common chickweed (*Stellaria media*), dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*), and yellow nutsedge (*Cyperus esculentus*) were planted and treated preemergence with the test chemical formulated in a non-phytotoxic solvent mixture which included a surfactant.

At the same time, plants selected from these crop and weed species were treated with postemergence applications of the test chemical formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage) for postemergence treatments. Treated plants and controls were maintained in a greenhouse for 12 to 14 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table F, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

Table F	Compound
500 g ai/ha	1
Postemergence	
Bentgrass	70
Bermudagrass, Turf	70
Bluegrass	95
Bluegrass, KY	30
Chickweed	100
Clover, White	100
Crabgrass, Large	90
Dallisgrass	60
Dandelion	95
Fescue, Hard	0
Goosegrass	50
Nutsedge, Yellow	15

Table F	Compound
250 g ai/ha	1
Postemergence	
Bentgrass	50
Bermudagrass, Turf	50
Bluegrass	70
Bluegrass, KY	0
Chickweed	85
Clover, White	100
Crabgrass, Large	75
Dallisgrass	75
Dandelion	85
Fescue, Hard	0
Goosegrass	40
Nutsedge, Yellow	15

Table F	Compound
125 g ai/ha	1
Postemergence	
Bentgrass	50
Bermudagrass, Turf	40
Bluegrass	45
Bluegrass, KY	0
Chickweed	85
Clover, White	100
Crabgrass, Large	70
Dallisgrass	15
Dandelion	75
Fescue, Hard	0
Goosegrass	35
Nutsedge, Yellow	10

Table F	Compound
62 g ai/ha	1
Postemergence	
Bentgrass	30
Bermudagrass, Turf	20
Bluegrass, KY	0

Table F	Compound
31 g ai/ha	1
Postemergence	
Bentgrass	0
Bermudagrass, Turf	0
Bluegrass	35

Table F	Compound
500 g ai/ha	1
Preemergence	
Bentgrass	100
Bermudagrass, Turf	90
Bluegrass	70

Chickweed	80
Clover, White	90
Crabgrass, Large	45
Dallisgrass	0
Dandelion	75
Fescue, Hard	0
Goosegrass	10
Nutsedge, Yellow	10

Table F	Compound
250 g ai/ha	1
Preemergence	
Bentgrass	90
Bermudagrass, Turf	80
Bluegrass	70
Bluegrass, KY	40
Chickweed	100
Clover, White	100
Crabgrass, Large	95
Dallisgrass	70
Dandelion	100
Fescue, Hard	60
Goosegrass	65
Nutsedge, Yellow	25

Table F	Compound
31 g ai/ha	1
Preemergence	
Bentgrass	50
Bermudagrass, Turf	10
Bluegrass	20
Bluegrass, KY	0

Bluegrass, KY	20
Chickweed	0
Clover, White	70
Crabgrass, Large	0
Dallisgrass	0
Dandelion	50
Fescue, Hard	0
Goosegrass	5
Nutsedge, Yellow	0

Table F	Compound
125 g ai/ha	1
Preemergence	
Bentgrass	60
Bermudagrass, Turf	50
Bluegrass	45
Bluegrass, KY	30
Chickweed	100
Clover, White	100
Crabgrass, Large	85
Dallisgrass	45
Dandelion	100
Fescue, Hard	60
Goosegrass	30
Nutsedge, Yellow	30

Table F	Compound
31 g ai/ha	1
Preemergence	
Chickweed	80
Clover, White	80
Crabgrass, Large	15
Dallisgrass	10

Bluegrass, KY	80
Chickweed	100
Clover, White	100
Crabgrass, Large	100
Dallisgrass	95
Dandelion	100
Fescue, Hard	90
Goosegrass	85
Nutsedge, Yellow	70

Table F	Compound
62 g ai/ha	1
Preemergence	
Bentgrass	60
Bermudagrass, Turf	40
Bluegrass	65
Bluegrass, KY	30
Chickweed	100
Clover, White	100
Crabgrass, Large	40
Dallisgrass	35
Dandelion	95
Fescue, Hard	60
Goosegrass	40
Nutsedge, Yellow	15

Table F	Compound
31 g ai/ha	1
Preemergence	
Dandelion	35
Fescue, Hard	50
Goosegrass	30
Nutsedge, Yellow	0

TEST G

Seeds or nutlets of plant species selected from bermudagrass (*Cynodon dactylon*), Surinam grass (*Brachiaria decumbens*), large crabgrass (*Digitaria sanguinalis*), green foxtail (*Setaria viridis*), goosegrass (*Eleusine indica*), johnsongrass (*Sorghum halepense*), kochia (*Kochia scoparia*), pitted morningglory (*Ipomoea lacunosa*), purple nutsedge (*Cyperus rotundus*), common ragweed (*Ambrosia elatior*), black mustard (*Brassica nigra*),

guineagrass (*Panicum maximum*), dallisgrass (*Paspalum dilatatum*), barnyardgrass (*Echinochloa crus-galli*), southern sandbur (*Cenchrus echinatus*), common sowthistle (*Sonchus oleraceous*), prickly sida (*Sida spinosa*), Italian ryegrass (*Lolium multiflorum*), common purslane (*Portulaca oleracea*), broadleaf signalgrass (*Brachiaria platyphylla*), common groundsel (*Senecio vulgaris*), common chickweed (*Stellaria media*), tropical spiderwort (*Commelina benghalensis*), annual bluegrass (*Poa annua*), downy bromegrass (*Bromus tectorum*), itchgrass (*Rottboellia cochinchinensis*), quackgrass (*Elytrigia repens*), Canada horseweed (*Conyza canadensis*), field bindweed (*Convolvulus arvensis*), spanishneedles (*Bidens bipinnata*), common mallow (*Malva sylvestris*), and Russian thistle (*Salsola kali*) were planted and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant.

At the same time, plants selected from these weed species were treated with postemergence applications of some of the test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage) for postemergence treatments. Treated plants and controls were maintained in a greenhouse for 12 to 21 days, after which time all species were compared to controls and visually evaluated.

At a different time, established container-grown grape (*Vitus vinifera*) vines, and olive (*Olea europaea*) and orange (*Citrus sinensis*) trees were treated with some of the test chemicals formulated in the same manner and applied to the soil surface and the lower 5 cm of the plant vines or trunks (post-directed application). Plants ranged in height from 30 to 100 cm. The applications were made using a hand sprayer delivering a volume of 990 L/ha. Treated plants and controls were maintained in a greenhouse for 28 days, after which time the treated plants were compared to controls and visually evaluated.

Also at a different time, seed pieces (nodes) of sugarcane (*Saccharum officinarum*) were planted and treated preemergence and/or postemergence with some of the test chemicals formulated in the same manner. Treated plants and controls were maintained in a greenhouse for 14 days, after which time the treated plants were compared to controls and visually evaluated.

Plant response ratings, summarized in Table G, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

Table G	Compound
500 g ai/ha	1
Postemergence	
Barnyardgrass	75
Bermudagrass	50
Bindweed, Field	95
Black Mustard	75
Bluegrass	50

Table G	Compound
375 g ai/ha	1
Postemergence	
Barnyardgrass	70
Bermudagrass	40
Bindweed, Field	95
Black Mustard	75
Bluegrass	50

Bromegrass, Downy	80
Crabgrass, Large	70
Dallisgrass	30
Foxtail, Green	60
Goosegrass	60
Groundsel	100
Guineagrass	95
Horseweed	100
Itchgrass	70
Johnsongrass	95
Mallow	95
Morningglory	100
Nutsedge, Purple	30
Prickly Sida	95
Purslane	100
Quackgrass	70
Ragweed	100
Ryegrass, Italian	40
Sandbur	95
Signalgrass	85
Sowthistle	100
Spanishneedles	95
Spiderwort	95
Surinam Grass	90

Table G	Compound		
250 g ai/ha	1	22	77
Postemergence			
Barnyardgrass	70	85	75
Bermudagrass	40	65	50
Bindweed, Field	95	100	100
Black Mustard	75	95	60
Bluegrass	40	75	40
Bromegrass, Downy	60	95	75
Chickweed	95	95	100
Crabgrass, Large	70	85	75

Bromegrass, Downy	70
Chickweed	100
Crabgrass, Large	70
Dallisgrass	30
Foxtail, Green	50
Goosegrass	60
Groundsel	100
Horseweed	100
Itchgrass	60
Johnsongrass	95
Kochia	95
Mallow	95
Morningglory	100
Nutsedge, Purple	30
Prickly Sida	95
Purslane	100
Quackgrass	70
Ragweed	100
Russian Thistle	100
Ryegrass, Italian	40
Sandbur	95
Signalgrass	75
Sowthistle	95
Spanishneedles	95
Spiderwort	95
Surinam Grass	90

Table G	Compound
125 g ai/ha	1
Postemergence	
Barnyardgrass	60
Bermudagrass	25
Bindweed, Field	95
Black Mustard	75
Bluegrass	30
Bromegrass, Downy	30
Chickweed	95
Crabgrass, Large	60

Dallisgrass	30	75	50
Foxtail, Green	30	75	40
Goosegrass	60	50	65
Groundsel	95	-	100
Guineagrass	95	100	75
Horseweed	100	-	80
Itchgrass	60	85	80
Johnsongrass	95	-	85
Kochia	-	100	98
Mallow	70	95	95
Morningglory	100	100	100
Nutsedge, Purple	20	15	40
Prickly Sida	90	95	80
Purslane	100	98	85
Quackgrass	60	85	60
Ragweed	95	100	100
Russian Thistle	100	100	-
Ryegrass, Italian	40	85	40
Sandbur	95	95	40
Signalgrass	75	85	70
Sowthistle	95	100	95
Spanishneedles	95	-	98
Spiderwort	95	98	100
Surinam Grass	85	95	70

Table G	Compound	
125 g ai/ha	22	77
Postemergence		
Barnyardgrass	25	65
Bermudagrass	40	35
Bindweed, Field	100	100
Black Mustard	95	60
Bluegrass	40	40
Bromegrass, Downy	95	65
Chickweed	85	90
Crabgrass, Large	85	75
Dallisgrass	25	35
Foxtail, Green	50	40

Dallisgrass	20
Foxtail, Green	20
Goosegrass	60
Groundsel	95
Guineagrass	70
Horseweed	70
Itchgrass	40
Johnsongrass	70
Mallow	60
Morningglory	100
Nutsedge, Purple	10
Prickly Sida	70
Purslane	100
Quackgrass	30
Ragweed	95
Russian Thistle	100
Ryegrass, Italian	10
Sandbur	60
Signalgrass	60
Sowthistle	95
Spanishneedles	95
Spiderwort	95
Surinam Grass	60

Table G	Compound			
62 g ai/ha	1	22	64	77
Postemergence				
Barnyardgrass	60	15	20	40
Bermudagrass	25	35	35	35
Bindweed, Field	90	100	90	98
Black Mustard	60	75	10	50
Bluegrass	20	15	0	0
Bromegrass, Downy	30	85	75	35
Chickweed	-	50	-	90
Crabgrass, Large	50	50	80	75
Dallisgrass	10	15	20	15
Foxtail, Green	10	25	0	35

Goosegrass	35	50
Groundsel	85	95
Guineagrass	95	65
Horseweed	–	80
Itchgrass	75	70
Johnsongrass	–	85
Kochia	100	98
Mallow	85	85
Morningglory	95	100
Nutsedge, Purple	0	0
Prickly Sida	95	80
Purslane	95	70
Quackgrass	75	60
Ragweed	98	98
Russian Thistle	100	–
Ryegrass, Italian	40	30
Sandbur	85	35
Signalgrass	50	60
Sowthistle	100	95
Spanishneedles	–	98
Spiderwort	95	90
Surinam Grass	65	65

Table G	Compound		
31 g ai/ha	22	64	77
Postemergence			
Barnyardgrass	0	20	10
Bermudagrass	35	35	20
Bindweed, Field	100	80	98
Black Mustard	75	0	40
Bluegrass	0	0	0
Bromegrass, Downy	65	40	20
Chickweed	50	–	80
Crabgrass, Large	35	70	70
Dallisgrass	0	0	0
Foxtail, Green	15	0	0
Goosegrass	15	0	15
Groundsel	65	0	75

Goosegrass	20	25	20	50
Groundsel	60	65	0	80
Guineagrass	60	65	0	65
Horseweed	–	–	60	75
Itchgrass	20	50	60	65
Johnsongrass	70	–	0	70
Kochia	–	98	90	98
Mallow	50	–	90	80
Morningglory	100	85	65	90
Nutsedge, Purple	–	0	35	0
Prickly Sida	70	90	75	80
Purslane	80	85	60	60
Quackgrass	10	65	35	40
Ragweed	75	98	100	95
Russian Thistle	100	100	–	–
Ryegrass, Italian	0	15	35	30
Sandbur	30	40	20	10
Signalgrass	20	25	30	50
Sowthistle	95	95	80	90
Spanishneedles	80	–	90	98
Spiderwort	95	85	90	75
Surinam Grass	30	35	10	25

Table G	Compound		
16 g ai/ha	22	64	77
Postemergence			
Barnyardgrass	0	20	0
Bermudagrass	15	20	10
Bindweed, Field	85	70	70
Black Mustard	50	0	25
Bluegrass	0	0	0
Bromegrass, Downy	15	20	0
Chickweed	–	–	10
Crabgrass, Large	15	50	60
Dallisgrass	0	0	0
Foxtail, Green	0	0	0
Goosegrass	5	0	0
Groundsel	65	0	40

Guineagrass	55	0	0
Horseweed	-	60	50
Itchgrass	25	0	35
Johnsongrass	-	0	65
Kochia	98	85	95
Mallow	60	90	75
Morningglory	85	20	60
Nutsedge, Purple	0	35	0
Prickly Sida	85	75	75
Purslane	55	0	20
Quackgrass	40	20	10
Ragweed	85	100	75
Russian Thistle	100	-	-
Ryegrass, Italian	5	20	20
Sandbur	15	20	0
Signalgrass	15	0	30
Sowthistle	85	80	90
Spanishneedles	-	90	95
Spiderwort	40	80	50
Surinam Grass	15	0	10

Table G	Compound
8 g ai/ha	64
Postemergence	
Barnyardgrass	0
Bermudagrass	0
Bindweed, Field	60
Black Mustard	0
Bluegrass	0
Bromegrass, Downy	0
Crabgrass, Large	30
Dallisgrass	0
Foxtail, Green	0
Goosegrass	0
Groundsel	0
Guineagrass	0
Horseweed	60
Itchgrass	0

Guineagrass	5	0	0
Horseweed	-	60	40
Itchgrass	15	0	0
Johnsongrass	-	0	20
Kochia	98	75	90
Mallow	40	80	65
Morningglory	50	0	50
Nutsedge, Purple	0	35	0
Prickly Sida	75	65	70
Purslane	50	0	20
Quackgrass	15	20	0
Ragweed	65	75	75
Russian Thistle	95	-	-
Ryegrass, Italian	0	10	0
Sandbur	0	0	0
Signalgrass	5	0	0
Sowthistle	75	80	75
Spanishneedles	-	75	75
Spiderwort	15	80	10
Surinam Grass	0	0	0

Table G	Compounds	
1500 g ai/ha	1	4
Post-Directed		
Grape	100	100
Olive	50	-
Orange	50	75

Table G	Compound
900 g ai/ha	4
Post-Directed	
Olive	50

Table G	Compounds	
500 g ai/ha	1	9
Postemergence		
Sugarcane	38	17

Johnsongrass	0
Kochia	65
Mallow	65
Morningglory	0
Nutsedge, Purple	0
Prickly Sida	40
Purslane	0
Quackgrass	0
Ragweed	75
Ryegrass, Italian	0
Sandbur	0
Signalgrass	0
Sowthistle	65
Spanishneedles	65
Spiderwort	65
Surinam Grass	0

Table G	Compounds		
500 g ai/ha	1	4	9
Preemergence			
Barnyardgrass	70	100	95
Bermudagrass	70	100	100
Bindweed, Field	100	100	100
Black Mustard	100	100	100
Bluegrass	85	100	100
Bromegrass, Downy	95	100	100
Chickweed	100	100	100
Crabgrass, Large	90	100	100
Dallisgrass	95	100	100
Foxtail, Green	90	100	100
Goosegrass	50	90	95
Groundsel	100	100	-
Guineagrass	100	100	100
Horseweed	100	100	100
Itchgrass	90	95	85
Johnsongrass	75	95	95
Kochia	100	-	-

Table G	Compounds	
250 g ai/ha	1	9
Postemergence		
Sugarcane	13	7

Table G	Compounds	
125 g ai/ha	1	9
Postemergence		
Sugarcane	3	0

Table G	Compounds	
62 g ai/ha	1	9
Postemergence		
Sugarcane	0	0

Table G	Compounds	
31 g ai/ha	1	9
Postemergence		
Sugarcane	0	0

Table G	Compound
375 g ai/ha	1
Preemergence	
Barnyardgrass	70
Bermudagrass	70
Bindweed, Field	100
Black Mustard	100
Bromegrass, Downy	95
Chickweed	100
Crabgrass, Large	90
Dallisgrass	95
Foxtail, Green	90
Goosegrass	50
Groundsel	100
Guineagrass	100
Horseweed	100
Itchgrass	85
Johnsongrass	75
Kochia	100
Mallow	95

Mallow	95	100	100
Morningglory	100	100	100
Nutsedge, Purple	100	100	-
Prickly Sida	100	100	100
Purslane	100	100	-
Quackgrass	95	100	100
Ragweed	100	100	100
Russian Thistle	100	100	-
Ryegrass, Italian	95	100	80
Sandbur	85	100	95
Signalgrass	95	95	100
Sowthistle	100	100	-
Spanishneedles	100	100	100
Spiderwort	100	100	100
Surinam Grass	100	95	90

Morningglory	100
Nutsedge, Purple	100
Prickly Sida	100
Purslane	100
Quackgrass	95
Ragweed	100
Russian Thistle	100
Ryegrass, Italian	95
Sandbur	85
Signalgrass	75
Sowthistle	100
Spanishneedles	100
Spiderwort	100
Surinam Grass	95

Table G	Compounds				
250 g ai/ha	1	4	9	22	77
Preemergence					
Barnyardgrass	50	80	85	80	90
Bermudagrass	30	95	95	30	60
Bindweed, Field	100	100	100	100	100
Black Mustard	85	100	100	75	95
Bluegrass	85	80	95	60	40
Bromegrass, Downy	95	100	70	75	75
Chickweed	95	100	100	100	100
Crabgrass, Large	90	100	90	80	90
Dallisgrass	50	95	80	50	85
Foxtail, Green	50	100	100	20	90
Goosegrass	50	70	95	0	55
Groundsel	100	100	-	50	100
Guineagrass	85	100	100	95	95
Horseweed	100	100	100	-	100
Itchgrass	80	80	80	65	90
Johnsongrass	60	85	95	80	95
Kochia	100	-	-	100	100
Mallow	95	100	100	80	80
Morningglory	100	100	100	90	100

Nutsedge, Purple	100	100	-	50	100
Prickly Sida	100	100	100	95	95
Purslane	95	100	-	75	100
Quackgrass	90	100	70	30	80
Ragweed	100	100	100	100	100
Russian Thistle	100	100	-	100	100
Ryegrass, Italian	30	100	75	50	75
Sandbur	70	90	90	85	100
Signalgrass	75	95	80	80	95
Sowthistle	100	100	-	100	100
Spanishneedles	100	100	100	-	-
Spiderwort	100	100	100	100	100
Surinam Grass	95	80	80	90	100

Table G	Compounds				
125 g ai/ha	1	4	9	22	77
Preemergence					
Barnyardgrass	20	70	70	70	85
Bermudagrass	20	90	95	0	10
Bindweed, Field	100	100	100	90	100
Black Mustard	80	95	75	65	90
Bluegrass	30	60	30	30	20
Bromegrass, Downy	20	70	50	20	10
Chickweed	95	100	100	90	100
Crabgrass, Large	30	75	90	80	85
Dallisgrass	10	50	70	40	30
Foxtail, Green	10	70	85	10	85
Goosegrass	-	60	60	0	25
Groundsel	100	95	-	-	80
Guineagrass	70	95	100	90	85
Horseweed	95	100	100	-	100
Itchgrass	30	70	60	40	85
Johnsongrass	40	75	80	50	85
Kochia	100	-	-	100	100
Mallow	80	100	100	80	80
Morningglory	100	100	100	90	100
Nutsedge, Purple	100	100	-	40	100
Prickly Sida	100	100	100	80	90
Purslane	60	100	-	70	100

Quackgrass	60	90	-	20	50
Ragweed	95	100	100	95	100
Russian Thistle	100	100	-	100	-
Ryegrass, Italian	10	60	50	0	40
Sandbur	30	80	80	70	100
Signalgrass	70	70	80	10	90
Sowthistle	100	100	-	100	100
Spanishneedles	100	100	100	-	-
Spiderwort	100	100	100	100	95
Surinam Grass	95	60	70	35	90

Table G	Compounds					
62 g ai/ha	1	4	9	22	64	77
Preemergence						
Barnyardgrass	0	50	30	30	10	75
Bermudagrass	10	20	10	0	0	0
Bindweed, Field	95	100	95	90	65	95
Black Mustard	30	95	70	60	35	85
Bluegrass	10	10	10	0	0	5
Bromegrass, Downy	0	30	10	0	0	0
Chickweed	70	100	-	-	0	90
Crabgrass, Large	20	60	70	40	35	80
Dallisgrass	0	0	10	0	0	15
Foxtail, Green	10	20	20	0	0	65
Goosegrass	0	10	10	0	0	5
Groundsel	60	95	-	-	40	-
Guineagrass	70	95	90	75	0	85
Horseweed	95	100	100	-	95	100
Itchgrass	10	70	30	20	20	45
Johnsongrass	20	60	40	20	0	75
Kochia	100	-	-	98	15	95
Mallow	50	100	90	75	0	50
Morningglory	95	100	70	60	0	100
Nutsedge, Purple	10	40	-	30	0	100
Prickly Sida	70	85	95	65	50	85
Purslane	10	60	-	50	35	75
Quackgrass	10	60	70	20	0	10
Ragweed	50	80	95	90	95	100
Russian Thistle	100	-	-	95	0	100

Ryegrass, Italian	0	30	20	0	0	0
Sandbur	0	30	-	0	0	100
Signalgrass	10	50	20	0	0	75
Sowthistle	95	100	-	90	90	100
Spanishneedles	100	100	100	-	35	-
Spiderwort	70	100	100	95	90	95
Surinam Grass	95	30	40	0	0	70

Table G	Compounds		
31 g ai/ha	22	64	77
Preemergence			
Barnyardgrass	20	0	55
Bermudagrass	0	0	0
Bindweed, Field	75	0	90
Black Mustard	35	20	60
Bluegrass	0	0	0
Bromegrass, Downy	0	0	0
Chickweed	50	0	70
Crabgrass, Large	40	0	45
Dallisgrass	0	0	5
Foxtail, Green	0	0	5
Goosegrass	0	0	5
Groundsel	0	10	60
Guineagrass	35	0	70
Horseweed	-	95	90
Itchgrass	0	0	10
Johnsongrass	0	0	65
Kochia	70	10	95
Mallow	50	0	40
Morningglory	50	0	90
Nutsedge, Purple	0	0	100
Prickly Sida	50	30	75
Purslane	0	0	60
Quackgrass	0	0	0
Ragweed	75	65	95
Russian Thistle	75	0	-
Ryegrass, Italian	0	0	0
Sandbur	0	0	20
Signalgrass	0	0	10

Table G	Compounds		
16 g ai/ha	22	64	77
Preemergence			
Barnyardgrass	10	0	50
Bermudagrass	0	0	0
Bindweed, Field	65	0	80
Black Mustard	30	0	60
Bluegrass	0	0	0
Bromegrass, Downy	0	0	0
Chickweed	0	-	-
Crabgrass, Large	0	0	45
Dallisgrass	0	0	0
Foxtail, Green	0	0	0
Goosegrass	0	0	0
Groundsel	-	0	50
Guineagrass	0	0	30
Horseweed	-	75	70
Itchgrass	0	0	0
Johnsongrass	0	0	10
Kochia	35	0	85
Mallow	50	-	30
Morningglory	20	0	70
Nutsedge, Purple	0	0	100
Prickly Sida	50	0	70
Purslane	0	0	45
Quackgrass	0	0	0
Ragweed	65	65	80
Russian Thistle	65	-	85
Ryegrass, Italian	0	0	0
Sandbur	0	0	0
Signalgrass	0	0	5

Sowthistle	75	35	100
Spanishneedles	–	0	–
Spiderwort	50	75	85
Surinam Grass	0	0	5

Sowthistle	35	0	80
Spanishneedles	–	0	–
Spiderwort	0	50	60
Surinam Grass	0	0	0

Table G	Compound
8 g ai/ha	64
Preemergence	
Barnyardgrass	0
Bermudagrass	0
Bindweed, Field	0
Black Mustard	0
Bluegrass	0
Bromegrass, Downy	0
Chickweed	0
Crabgrass, Large	0
Dallisgrass	0
Foxtail, Green	0
Goosegrass	0
Groundsel	0
Guineagrass	0
Horseweed	0
Itchgrass	0
Johnsongrass	0

Table G	Compound
8 g ai/ha	64
Preemergence	
Kochia	0
Mallow	0
Morningglory	0
Nutsedge, Purple	0
Prickly Sida	0
Purslane	0
Quackgrass	0
Ragweed	65
Russian Thistle	0
Ryegrass, Italian	0
Sandbur	0
Signalgrass	0
Sowthistle	0
Spanishneedles	0
Spiderwort	0
Surinam Grass	0

Table G	Compound
375 g ai/ha	1
Preemergence	
Sugarcane	0

Table G	Compound
125 g ai/ha	1
Preemergence	
Sugarcane	0

Table G	Compound
250 g ai/ha	1
Preemergence	
Sugarcane	0

Table G	Compound
62 g ai/ha	1
Preemergence	
Sugarcane	0

TEST H

This test evaluated the effect of mixtures of compound 1 with diflufenzopyr on several plant species. Seeds of test plants consisting of large crabgrass (DIGSA, *Digitaria sanguinalis* (L.) Scop.), lambsquarters (CHEAL, *Chenopodium album* L.), redroot pigweed (AMARE, *Amaranthus retroflexus* L.), cocklebur (XANST, *Xanthium strumarium* L.),

barnyardgrass (ECHCG; *Echinochloa crus-galli* (L.) Beauv.), corn (ZEAMD, *Zea mays* L. cv. 'Pioneer 33G26'), scarlet (red) morningglory (IPOCO, *Ipomoea coccinea* L.), giant foxtail (SETFA, *Setaria faberi* Herrm.) and velvetleaf (ABUTH, *Abutilon theophrasti* Medik.) were planted in pots containing Redi-Earth® planting medium (Scotts Company, 14111 Scottslawn Road, Marysville, Ohio 43041) comprising spaghnum peat moss, vermiculite, wetting agent and starter nutrients. Seeds of small-seeded species were planted about 1 cm deep; larger seeds were planted about 2.5 cm deep. Plants were grown in a greenhouse using supplemental lighting to maintain a photoperiod of about 14 hours; daytime and nighttime temperatures were about 25–30 °C and 22–25 °C, respectively. Balanced fertilizer was applied through the watering system. The plants were grown for 7 to 11 days so that at time of treatment the plants ranged in height from 2 to 18 cm (1- to 4-leaf stage). Treatments consisted of Compound 1 and diflufenzopyr alone and in combination, suspended or dissolved in an aqueous solvent comprising glycerin and Tween nonionic surfactant and applied as a foliage spray using a volume of 541 L/ha. Each treatment was replicated four times. The application solvent was observed to have no effect compared to untreated check plants. Treated plants and controls were maintained in the greenhouse and watered as needed with care to not wet the foliage for the first 24 hours after treatment. The effects on the plants approximately 3 weeks after treatment were visually compared to untreated controls. Plant response ratings were calculated as the means of the four replicates, based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. Colby's Equation was used to determine the herbicidal effects expected from the mixtures. Colby's Equation (Colby, S. R. "Calculating Synergistic and Antagonistic Responses of Herbicide Combinations," *Weeds*, 15(1), pp 20–22 (1967)) calculates the expected additive effect of herbicidal mixtures, and for two active ingredients is of the form:

$$P_{a+b} = P_a + P_b - (P_a P_b / 100)$$

wherein P_{a+b} is the percentage effect of the mixture expected from additive contribution of the individual components,

P_a is the observed percentage effect of the first active ingredient at the same use rate as in the mixture, and

P_b is the observed percentage effect of the second active ingredient at the same use rate as in the mixture.

The results and additive effects expected from Colby's Equation are listed in Table H.

Table H – Observed and Expected Results from Compound 1 Alone and in Combination with Diflufenzopyr*

Application Rate (g a.i./ha)		DIGSA		CHEAL		AMARE		XANST		ECHCG	
Cmpd 1	Diflufenzopyr	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.
125	–	81	–	100	–	100	–	97	–	90	–
62	–	37	–	100	–	97	–	98	–	42	–
31	–	7	–	98	–	91	–	87	–	25	–
–	50	8	–	80	–	95	–	68	–	23	–
–	25	1	–	76	–	91	–	60	–	10	–
–	12	0	–	61	–	73	–	43	–	5	–
125	50	88	83	100	100	100	100	100	99	93	92
62	25	77	38	100	100	100	100	92	99	85	48
31	12	62	7	100	99	100	98	100	93	85	29

Application Rate (g a.i./ha)		ZEAMD		IPOCO		SETFA		ABUTH	
Cmpd 1	Diflufenzopyr	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.
125	–	22	–	100	–	65	–	93	–
62	–	5	–	97	–	4	–	26	–
31	–	2	–	92	–	2	–	14	–
–	50	0	–	82	–	59	–	68	–
–	25	0	–	83	–	58	–	78	–
–	12	0	–	77	–	41	–	50	–
125	50	56	22	100	100	89	86	100	98
62	25	32	5	100	99	72	60	92	84
31	12	8	2	99	98	73	42	62	57

* Application rates are grams of active ingredient per hectare (g a.i./ha). "Obsd." is observed effect. "Exp." is expected effect calculated from Colby's Equation.

As can be seen from the results listed in Table H, most of the observed results were greater than expected from the Colby Equation, and in some cases much greater. Most notable was the greater than additive effect observed on crabgrass, barnyardgrass, corn and giant foxtail. The increase was less noticeable for other test species, but primarily because the expected effect was already near 100% at the rates tested.

TEST I

This test evaluated the effect of mixtures of compound 9 with metsulfuron-methyl and with a 5:1 by weight combination of chlorsulfuron and metsulfuron-methyl on several plant species. Seeds of test plants consisting of wheat (TRZAW; *Triticum aestivum*), wild

buckwheat, (POLCO; *Polygonum convolvulus*), redroot pigweed (AMARE; *Amaranthus retroflexus*), wild mustard (SINAR; *Sinapis arvensis*), catchweed bedstraw (GALAP; *Galium aparine*), Russian thistle (SASKR; *Salsola kali*), common chickweed (STEME; *Stellaria media*), kochia (KCHSC; *Kochia scoparia*), and lambsquarters (CHEAL; *Chenopodium album*) were planted into a blend of loam soil and sand. Plants were grown in a greenhouse using supplemental lighting to maintain a photoperiod of about 14 hours; daytime and nighttime temperatures were about 23 °C and 16 °C, respectively. Balanced fertilizer was applied through the watering system. The plants were grown for 10 to 23 days so that at time of treatment the plants ranged from 2- to 8-leaf stage. Treatments consisted of Compound 9, metsulfuron-methyl, and chlorsulfuron–metsulfuron-methyl (5:1) alone and in combination. The treatments were formulated in a non-phytotoxic solvent mixture which included a surfactant and applied as a foliage spray using a volume of 280–458 L/ha. Each treatment was replicated three times. The application solvent was observed to have no effect compared to untreated check plants. Treated plants and controls were maintained in the greenhouse and watered as needed with care to not wet the foliage for the first 24 hours after treatment. The effects on the plants approximately 17 days after treatment were visually compared to untreated controls. Plant response ratings were calculated as the means of the three replicates, based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. Colby's Equation was used to determine the herbicidal effects expected from the mixtures. The results and additive effects expected from Colby's Equation are listed in Table I.

Table I – Observed and Expected Results from Compound 9 Alone and in Combination with Metsulfuron-Methyl and with Chlorsulfuron–Metsulfuron-Methyl (5:1)*

Application Rate (g a.i./ha)		POLCO		AMARE		SINAR		GALAP		KCHSC	
Compound 9	Metsulfuron-Methyl	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.
8	–	27	–	70	–	47	–	87	–	87	–
4	–	17	–	62	–	45	–	83	–	70	–
–	8	0	–	0	–	0	–	0	–	0	–
–	4	0	–	0	–	0	–	0	–	0	–
8	8	32	27	58	70	45	47	85	87	70	87
8	4	38	27	77	70	48	47	82	87	80	87
4	8	38	17	65	62	48	45	85	83	85	70
4	4	30	17	52	62	33	45	80	83	80	70

Application Rate (g a.i./ha)		SASKR		STEME		CHEAL		TRZAW	
Compound 9	Metsulfuron-Methyl	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.
8	–	73	–	55	–	83	–	12	–
4	–	50	–	47	–	45	–	8	–
–	8	0	–	0	–	0	–	0	–
–	4	0	–	0	–	0	–	0	–
8	8	68	73	43	55	73	83	8	12
8	4	67	73	55	55	88	83	7	12
4	8	55	50	50	47	60	45	8	8
4	4	55	50	52	47	48	45	3	8

Application Rate (g a.i./ha)		TRZAW	
Compound 9	Chlorsulfuron–Metsulfuron-Methyl	Obsd.	Exp.
16	–	43	–
8	–	30	–
–	20	35	–
–	10	3	–
16	20	42	63
16	10	33	45
8	20	33	55
8	10	22	32

* Application rates are grams of active ingredient per hectare (g a.i./ha). "Obsd." is observed effect. "Exp." is expected effect calculated from Colby's Equation.

As can be seen from the results listed in Table I, some of the observed results for weeds were greater than expected from the Colby Equation. Most notable was the greater than additive effect observed on wild buckwheat, kochia, and lambsquarters.

In addition, observed results for nearly all treatments on wheat were less than expected from the Colby Equation, suggesting crop safening.

TEST J

This test evaluated the effect of mixtures of compound 58 with azimsulfuron on several plant species. Three plastic pots (ca. 16-cm diameter) per rate were partially filled with sterilized Tama silt loam soil comprising a 35:50:15 ratio of sand, silt and clay and 2.6% organic matter. Separate plantings for each of the three pots were as follows. Seeds from the U.S. of ducksalad (HETLI; *Heteranthera limosa*), smallflower umbrella sedge

(CYPDI; *Cyperus difformis*) and purple redstem (AMMCO; *Ammannia coccinea*), were planted into one 16-cm pot for each rate. Seeds from the U.S. of bearded sprangletop (LEFUF; *Leptochloa fusca* ssp. *fascicularis*), one stand of 9 or 10 water-seeded rice seedlings (ORYSW; *Oryza sativa* cv. 'Japonica – M202'), and one stand of 6 transplanted rice seedlings (ORYSP; *Oryza sativa* cv. 'Japonica – M202') were planted into one 16-cm pot for each rate. Seeds from the U.S. of barnyardgrass (ECHCG; *Echinochloa crus-galli*), late watergrass (ECOR2; *Echinochloa oryzicola*), early watergrass (ECHOR; *Echinochloa oryzoides*) and junglerice (ECHCO; *Echinochloa colona*) were planted into one 16-cm pot for each rate. Plantings were sequential so that crop and weed species were at the 2.0 to 2.5-leaf stage at time of treatment.

Potted plants were grown in a greenhouse with day/night temperature settings of 29.5/26.7 °C, and supplemental balanced lighting was provided to maintain a 16-hour photoperiod. Test pots were maintained in the greenhouse until test completion.

At time of treatment, test pots were flooded to 3 cm above the soil surface and then treated by application directly to the paddy water of test compounds formulated in a non-phytotoxic solvent mixture which included a surfactant. The pots were maintained at the 3-cm water depth for the duration of the test. Treatments consisted of compound 58 and azimsulfuron alone and in combination. Effects of treatments on rice and weeds were visually evaluated by comparison to untreated controls after 21 days. Plant response ratings were calculated as the means of the three replicates and are summarized in Table J. The ratings are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result. Colby's Equation was used to determine the herbicidal effects expected from the mixtures. The results and additive effects expected from Colby's Equation are listed in Table J.

Table J – Observed and Expected Results from Compound 58 Alone and in Combination with Azimsulfuron*

Application Rate (g a.i./ha)		ORYSW		ORYSP		AMMCO		HETLI		CYPDI	
Cmpd 58	Azimsulfuron	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.
64	–	20	–	0	–	90	–	100	–	100	–
32	–	10	–	0	–	30	–	100	–	100	–
16	–	10	–	0	–	0	–	100	–	100	–
–	8	10	–	0	–	95	–	100	–	100	–
–	4	0	–	0	–	0	–	30	–	100	–
–	2	0	–	0	–	0	–	30	–	95	–
64	8	10	28	15	0	95	100	100	100	100	100
32	8	0	19	10	0	95	97	100	100	100	100
16	8	10	19	10	0	80	95	100	100	100	100
64	4	0	20	0	0	70	90	100	100	100	100
32	4	0	10	0	0	70	30	100	100	100	100
16	4	15	10	0	0	70	0	100	100	100	100
64	2	0	20	0	0	70	90	100	100	100	100
32	2	0	10	0	0	30	30	100	100	100	100
16	2	0	10	0	0	0	0	100	100	100	100

Application Rate (g a.i./ha)		LEFUF		ECHCG		ECOR2		ECHOR		ECHCO	
Compound 58	Azimsulfuron	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.	Obsd.	Exp.
64	–	20	–	0	–	0	–	0	–	0	–
32	–	0	–	0	–	0	–	0	–	0	–
16	–	0	–	0	–	0	–	0	–	0	–
–	8	0	–	30	–	50	–	40	–	40	–
–	4	0	–	0	–	0	–	0	–	0	–
–	2	0	–	0	–	0	–	0	–	0	–
64	8	0	20	55	30	60	50	55	40	60	40
32	8	0	0	45	30	45	50	65	40	55	40
16	8	0	0	30	30	45	50	30	40	40	40
64	4	0	20	35	0	50	0	20	0	30	0
32	4	0	0	10	0	30	0	20	0	20	0
16	4	0	0	20	0	0	0	20	0	20	0
64	2	0	20	20	0	0	0	0	0	0	0
32	2	0	0	0	0	0	0	0	0	0	0
16	2	0	0	0	0	0	0	0	0	0	0

* Application rates are grams of active ingredient per hectare (g a.i./ha). "Obsd." is observed effect. "Exp." is expected effect calculated from Colby's Equation.

TEST K

Seeds of plant species selected from sulfonylurea herbicide-susceptible (SU-susceptible) and sulfonylurea herbicide-resistant (SU-resistant) catchweed bedstraw (GALAP; *Galium aparine*) and wheat (TRZAW; *Triticum aestivum*) were treated with postemergence applications of test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant. Plants were treated at the 2–3 leaf stage and 2 whorl stage for wheat and catchweed bedstraw, respectively. Treated plants and controls were maintained in a controlled growth environment for 15 days after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table K, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

Table K – Results from Treatment of Wheat and Sulfonylurea Susceptible and Resistant Catchweed Bedstraw with Compounds 1 and 9 and Chlorsulfuron

Application Rate (g a.i./ha)			TRZAW	GALAP SU-Susceptible	GALAP SU-Resistant
Compound 1	Compound 9	Chlorsulfuron			
125	–	–	38	100	100
62	–	–	30	100	100
31	–	–	25	98	100
16	–	–	0	98	100
8	–	–	0	80	100
4	–	–	0	63	100
–	125	–	40	100	100
–	62	–	38	100	100
–	31	–	38	100	100
–	16	–	25	100	100
–	8	–	20	100	100
–	4	–	0	75	100
–	–	16	20	100	5

As can be seen from Table K, while chlorosulfuron had little effect on the sulfonylurea-resistant biotype of *Galium aparine* in this test, Compounds 1 and 9 gave good control of both resistant and susceptible biotypes.

TEST L

This field study included treatments that consisted of Compound 1 and nicosulfuron alone and in combination on Canada thistle (*Cirsium arvense*) and daisy fleabane (*Erigeron spp.*). The plants ranged from 20 to 30 cm in height at the time of application during the month of May in the vicinity of Newark, Delaware. Compound 1 was formulated as a wettable powder containing 25% active ingredient by weight. Nicosulfuron was in the form of Accent® Herbicide, a water-dispersible granule formulation containing 75% active ingredient by weight. The formulations were dispersed in water in the sprayer tank before treatment. The treatments were made using a backpack sprayer calibrated to deliver 24 gallons per acre (224 L per hectare) to a 10 ft x 30 ft (3 m x 9 m) plot. Each treatment was replicated two times. The effects on the plants approximately 56 days after treatment were visually compared to untreated controls. Plant response ratings were calculated as the means of the two replicates, based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. Colby's Equation was used to determine the herbicidal effects expected from the mixture. The results and additive effects expected from Colby's Equation are listed in Table L.

Table L – Observed (Obsd.) and Expected (Exp.) Results from Compound 1 Alone and in Combination with Nicosulfuron*

Application Rate (g a.i./ha)		*Cirsium arvense*		*Erigeron spp.*	
Compound 1	Nicosulfuron	Obsd.	Exp.	Obsd.	Exp.
125	–	73	–	53	–
–	18	15	–	28	–
125	18	98	77	85	66

* Application rates are grams of active ingredient per hectare (g a.i./ha). "Obsd." is observed effect. "Exp." is expected effect calculated from Colby's Equation.

Table L shows that a synergistic effect was apparent in this test from the combination of compound 1 and nicosulfuron.